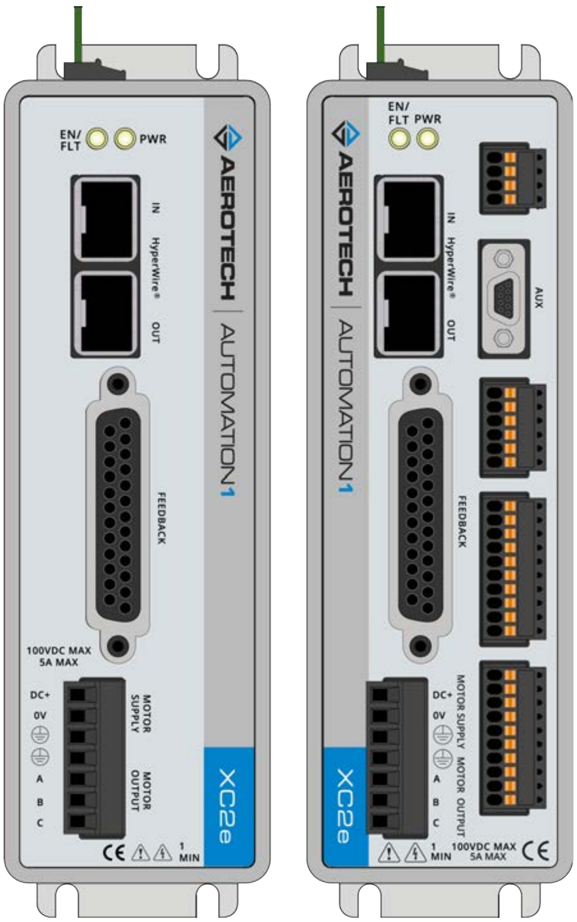
Automation1 XC2e High-Performance PWM Digital Drive

HARDWARE MANUAL

Revision 2.01



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Go to the Global Technical Support Portal for information and support about your Aerotech, Inc. products. The website supplies software, product manuals, Help files, training schedules, and PC-to-PC remote technical support. If necessary, you can complete Product Return (RMA) forms and get information about repairs and spare or replacement parts. To get help immediately, contact a service office or your sales representative. Include your customer order number in your email or have it available before you call.

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EU Declaration of Conformity

Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238-2811 USA
Product	XC2e
Model/Types	All

This is to certify that the aforementioned product is in accordance with the applicable requirements of the following Directive(s):

2014/30/EU	Electromagnetic Compatibility (EMC)
2014/35/EU	Low Voltage Directive
EU 2015/863	Directive, Restricted Substances (RoHS 3)

and has been designed to be in conformity with the applicable requirements of the following Standard(s) when installed and used in accordance with the manufacturer's supplied installation instructions.

EN 61326-1:2013	EMC Requirements for Electrical Equipment
EN 61010-1:2010/A1:2019	Safety Requirements for Electrical Equipment
EN ISO 13849-1:2015	Safety Related Parts of Control Systems

Authorized Representative:	Simon Smith, European Director
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Location	Pittsburgh, PA
Date	3/25/2021

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Agency Approvals

Aerotech tested its XC2e drives and found that they obey the standards that follow:

Approval:	CUS NRTL
Approving Agency:	TUV SUD America Inc.
Certificate #:	U8V 068995 0028 Rev. 02
Standards:	CAN/CSA-C22.2 No. 61010-1:2012/U2:2016-04; EN 61010-1:2010/A1:2019; UL 61010-1:2012/R:2016-04

Approval:	Safety Components (STO)
Approving Agency:	TUV SUD
Certificate #:	Z10 068995 0030 Rev. 00
Standards:	IEC 61508-1:2010 (up to SIL 3)

Visit https://www.tuev-sued.de/product-testing/certificates to view Aerotech's TÜV SÜD certificates. Type the certificate number listed above in the search bar or type "Aerotech" for a list of all Aerotech certificates.

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Safety Procedures and Warnings

IMPORTANT: This manual tells you how to carefully and correctly use and operate the XC2e drive.

- Read all parts of this manual before you install or operate the XC2e drive or before you do maintenance to your system.
- To prevent injury to you and damage to the equipment, obey the precautions in this manual.
- All specifications and illustrations are for reference only and were complete and accurate as of the release of this manual. To find the newest information about this product, refer to www.aerotech.com.

If you do not understand the information in this manual, contact Aerotech Global Technical Support.

IMPORTANT: This product has been designed for light industrial manufacturing or laboratory environments. If the product is used in a manner not specified by the manufacturer:

- The protection provided by the equipment could be impaired.
- The life expectancy of the product could be decreased.

DANGER: To decrease the risk of electrical shock, injury, death, and damage to the equipment, obey the precautions that follow.

1. Before you do maintenance to the equipment, disconnect the electrical power.
2. Restrict access to the XC2e when it is connected to a power source.
3. Do not connect or disconnect electrical components, wires, and cables while this product is connected to a power source.
4. Wait at least one (1) minute after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.
5. Supply each operator with the necessary protection from live electrical circuits.
6. Make sure that all components are grounded correctly and that they obey the local electrical safety requirements.
7. Install the necessary precautions to supply safety and protection to the operator.

DANGER: System travel can cause crush, shear, or pinch injuries. Restrict access to all motor and stage parts while your system is connected to a power source.

WARNING: To prevent damage to the equipment and decrease the risk of electrical shock and injury, obey the precautions that follow.

1. Make sure that all system cables are correctly attached and positioned.
2. Do not use the cables or the connectors to lift or move this product.
3. Use this product only in environments and operating conditions that are approved in this manual.
4. Only trained operators should operate this equipment.

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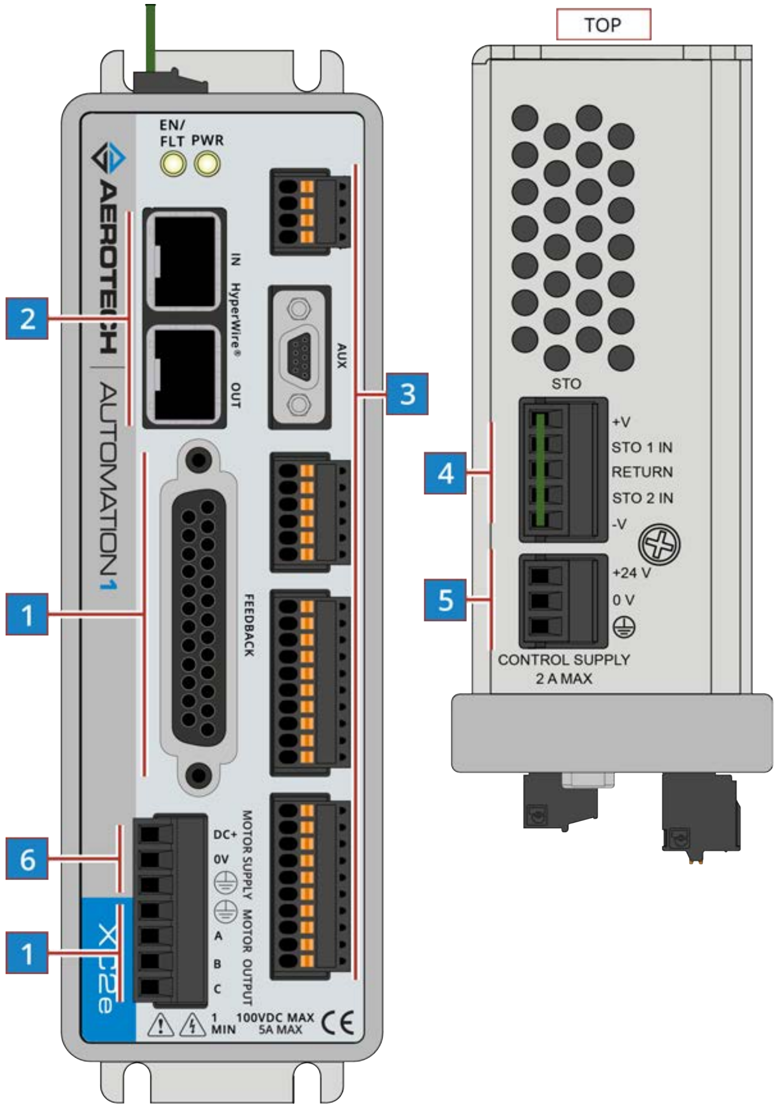
Installation Overview

This image shows the order in which to make connections and settings that are typical to the XC2e. If a custom interconnect drawing was supplied with your system, that drawing is on your Storage Device and shows as a line item on your Sales Order in the Integration section.



1	Connect the motor to the amplifier Motor Output connector.	Section 2.2.
	Connect the motor to the amplifier Feedback connector.	Section 2.3.
2	Connect a PC HyperWire port to the HyperWire In port.	Section 2.5.
3	Connect additional I/O as required by your application (if you purchased the I/O option).	Chapter 3
4	Connect the Safe Torque Off (STO).	Section 2.4.
5	Connect the power supply to the Control Supply connector.	Section 2.1.1.
6	Connect the motor power to the Motor Supply connector.	Section 2.1.2.

Figure 1: Installation Connection Overview

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Chapter 1: Introduction

The XC2e is a high performance digital drive based on the HyperWire communication protocol. The drive provides deterministic behavior, auto-identification, is fully software configurable. A double precision floating point DSP controls the digital PID and current loops in the XC2e.

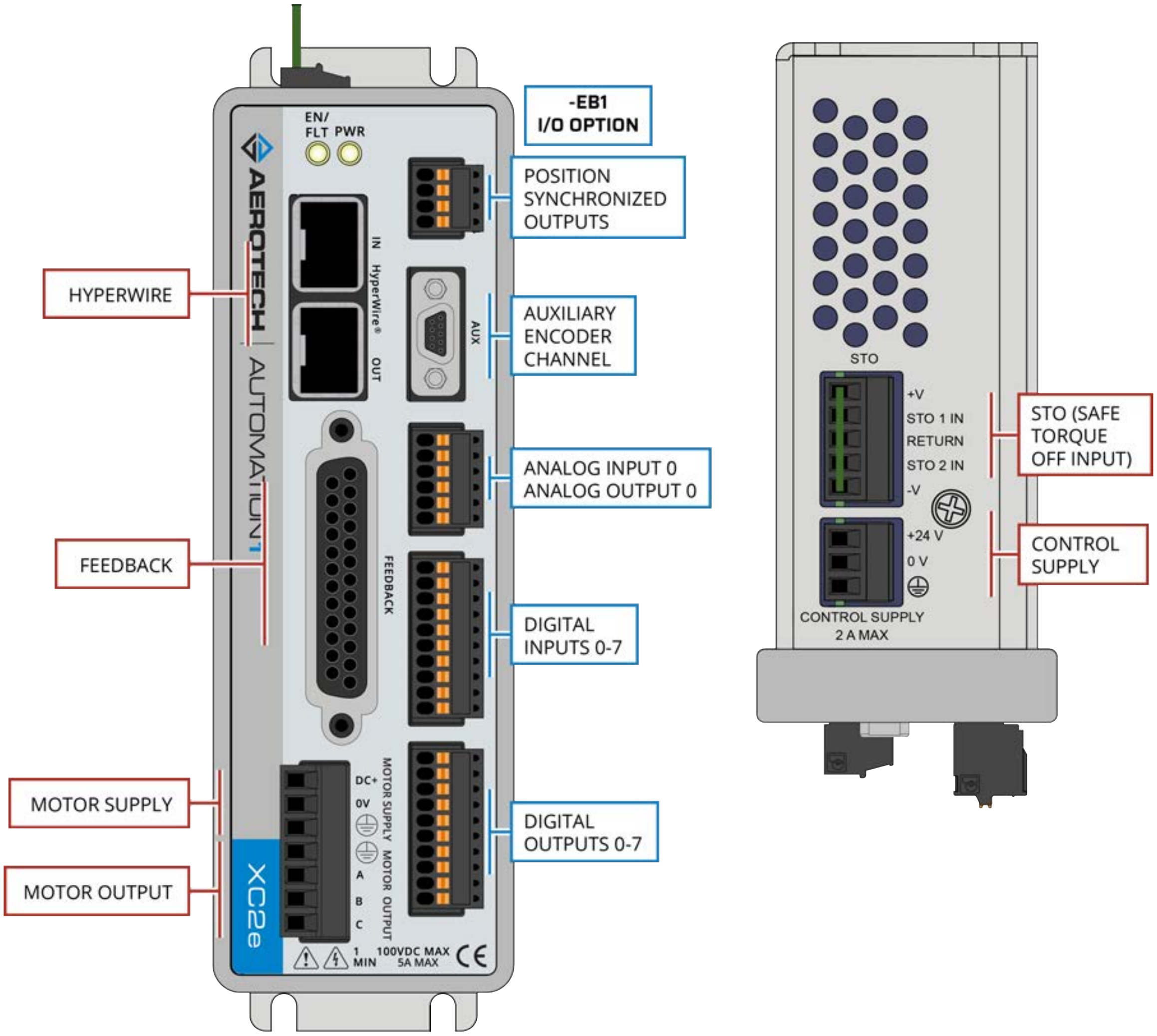


Figure 1-1: XC2e High Performance PWM Amplifier

Table 1-1: Feature Summary

Standard Features		
• 24 VDC control supply input		Section 2.1.1.
• 15-100 VDC motor supply inputs		Section 2.1.2.
• Line driver square wave quadrature encoder input for position and velocity feedback		Section 2.3.1.
• Absolute Encoder support		Section 2.3.1.2.
• One fail-safe brake output		Section 2.3.6.
• Two STO sense inputs		Section 2.4.
Options		
Peak Current		Section 1.1.
-10	10 A Peak, 5 A Continuous Current	
Expansion Board		Chapter 3
-EB0	No expansion board	
-EB1	I/O expansion board • 16-bit analog output (±10 V) • 16-bit differential analog input (±10 V) • 8 digital logic inputs (5 - 24 VDC), can be connected to current sourcing or sinking devices • 8 digital logic outputs (5 - 24 VDC), can be connected as current sourcing or sinking • Digital logic laser firing (PSO) output	
PSO (requires -EB1 option)		Section 3.1.
-PSO1	One-axis PSO firing (includes One-axis Part-Speed PSO)	
-PSO2	Two-axis PSO firing (includes Three-axis Part-Speed PSO)	
-PSO5	Two-axis Part-Speed PSO firing, which uses the PSO firing circuit based off of the commanded vector velocity of up to 2 axes (includes One-Axis PSO).	
-PSO6	Three-axis Part-Speed PSO firing, which uses the PSO firing circuit based off of the commanded vector velocity of 3 or more axes (includes One-Axis PSO).	
Multiplier		Section 2.3.1.3.
-MX0	No encoder multiplier	
-MX2	Interpolation circuit allowing for analog sine wave input on the primary encoder channel with an interpolation factor of 65,536.	
-MX3	Interpolation circuit allowing for analog sine wave input on the primary encoder channel with an interpolation factor of 65,536 and an auxiliary encoder channel with an interpolation factor of 16,384.	
Version		
-DEFAULT	Firmware Matches Software Line	
-LEGACY	Legacy Firmware Version X.XX.XXX	

The block diagram that follows shows a summary of the connector signals.

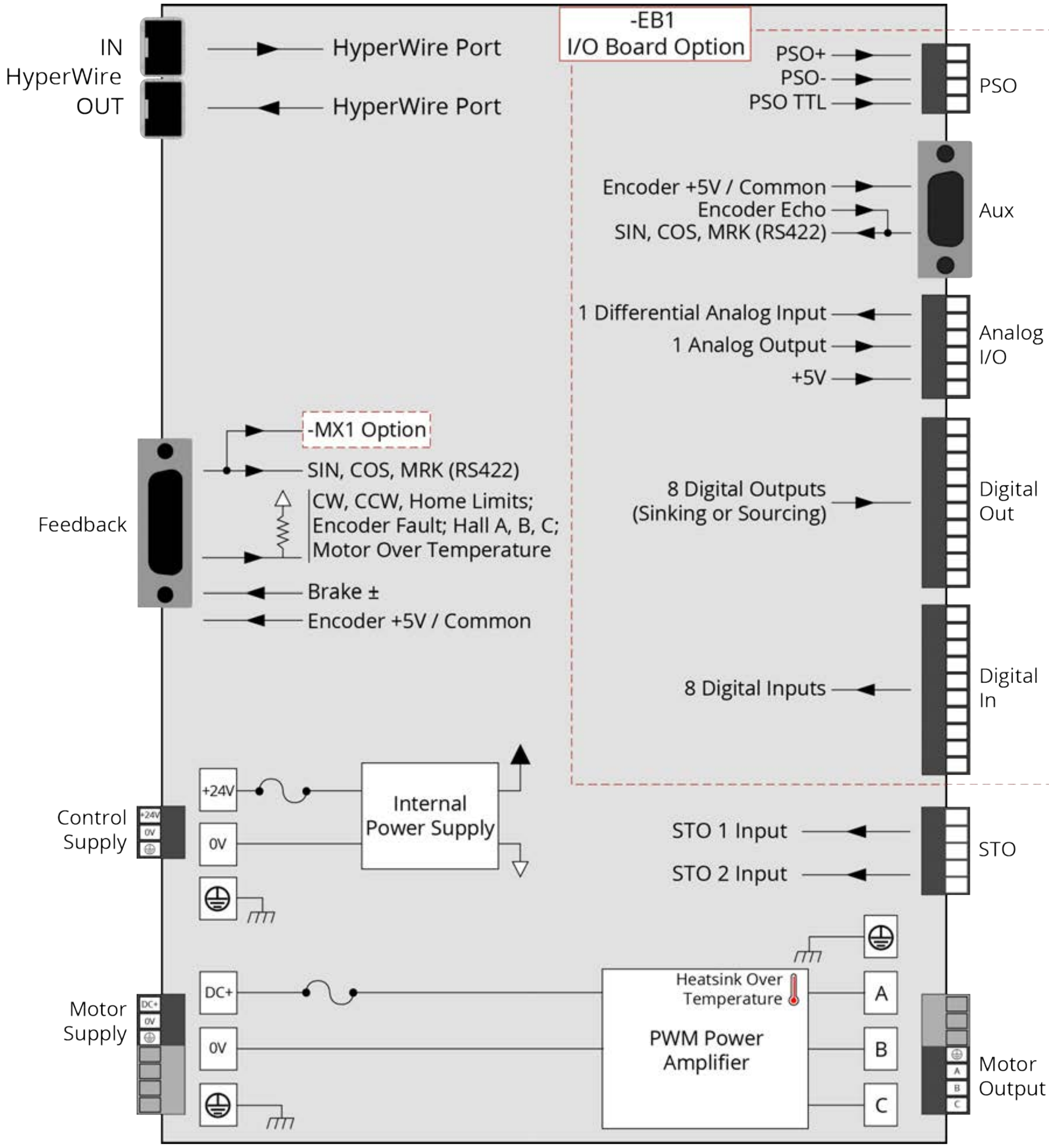


Figure 1-2: Functional Diagram

1.1. Electrical Specifications

Table 1-2: Electrical Specifications

Description		XC2e-10
Motor Supply	Input Voltage	15-100 VDC max
	Input Current (Continuous)	5 A_{rms}
	Input Current	Refer to Section 1.1.1. System Power Requirements
Control Supply	Input Voltage	24 VDC
	Input Current	2 A max, 0.4 A typical without brake
Output Voltage (1)		15-100 VDC
Peak Output Current (1 second)		10 A
Continuous Output Current		5 A
Power Amplifier Bandwidth		2500 Hz maximum (software selectable)
Power Amplifier Efficiency		85% - 95% (2)
PWM Switching Frequency		20 kHz
Minimum Load Inductance		0.1 mH @ 100 VDC
User Power Supply Output		5 VDC (@ 500 mA)
Modes of Operation		Brushless; Brush; Stepper
Protective Features		Output short circuit; Peak over current; RMS over current; Over temperature; Control power supply under voltage; Power stage bias supply under voltage

(1) DC input voltage and load dependent.
(2) Dependent on total output power: efficiency increases with increasing output power.

1.1.1. System Power Requirements

The following equations can be used to determine total system power requirements. The actual power required from the mains supply will be the combination of actual motor power (work), motor resistance losses, and efficiency losses in the power electronics or power transformer.

Use an EfficiencyFactor of approximately 90% in the following equations.

Brushless Motor

Output Power

Rotary Motors	Power Output [W] = Torque [N·m] * Angular velocity[rad/sec]
Linear Motors	Power Output [W] = Force [N] * Linear velocity[m/sec]
Rotary or Linear Motors	Power Output [W] = Bemf [V] * I(rms) * 3

Power Loss = 3 * I(rms)^2 * R(line-line)/2

Power Input = (Power Output + Power Loss) / EfficiencyFactor

DC Brush Motor

Power Output [W] = Torque [N·m] * Angular velocity[rad/sec]

Power Loss = I(rms)^2 * R

Power Input = (Pout + Ploss) / EfficiencyFactor

1.2. Mechanical Specifications

1.2.1. Mounting and Cooling

Install the XC2e in an IP54 compliant enclosure to comply with safety standards. Make sure that there is sufficient clearance surrounding the drive for free airflow and for the cables and connections.

Table 1-3: Mounting Specifications

		XC2e
Customer-Supplied Enclosure		IP54 Compliant
		For DIN Rail Mounting, refer to Section 4.1. DIN Rail Mounting
Weight		~0.54 kg
Mounting Hardware		M3.5 [#6] screws (four locations, not included)
Mounting Orientation		Vertical (typical)
Dimensions		Refer to Section 1.2.2. Dimensions
Minimum Clearance	Airflow	~25 mm
	Connectors	~100 mm
Operating Temperature		Refer to Section 1.3. Environmental Specifications

1.2.2. Dimensions

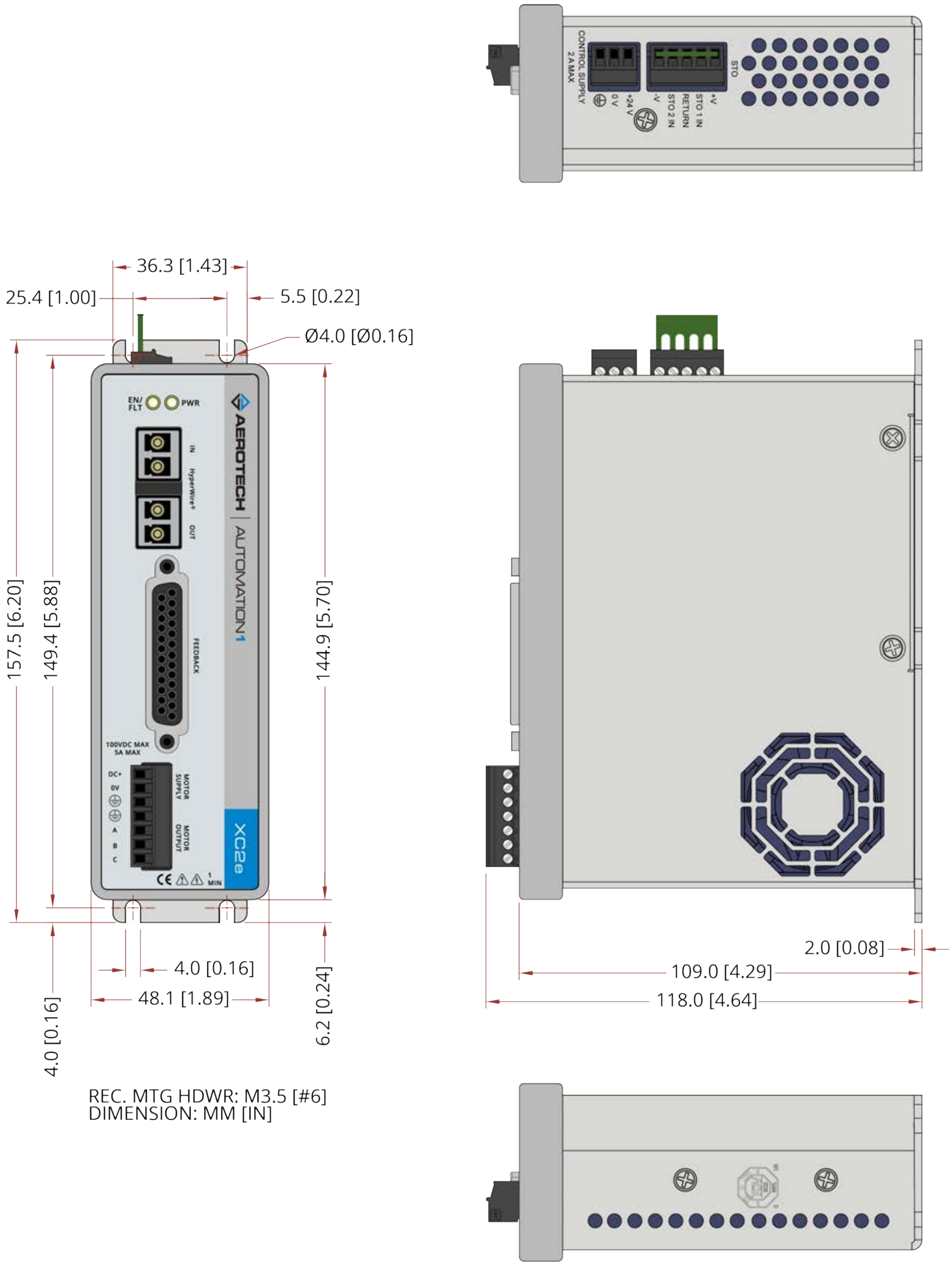


Figure 1-3: Dimensions

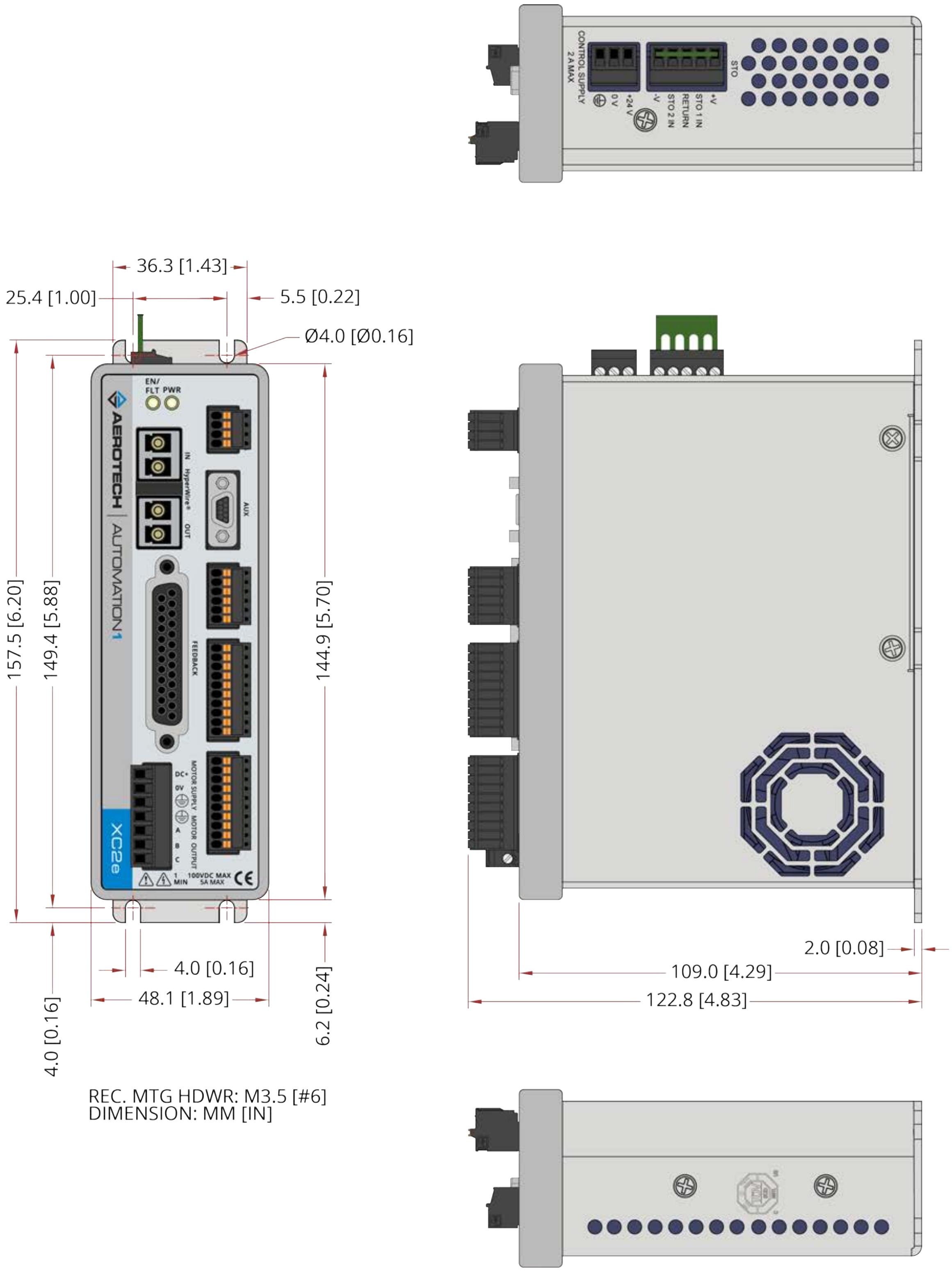


Figure 1-4: Dimensions [-EB1]

1.3. Environmental Specifications

Table 1-4: Environmental Specifications

Ambient Temperature	Operating: 0° to 40°C (32° to 104° F)
	Storage: -30° to 85°C (-22° to 185° F)
Humidity Non-condensing	The maximum relative humidity is 80% for temperatures that are less than 31°C and decreases linearly to 50% relative humidity at 40°C.
Operating Altitude	0 m to 2,000 m (0 ft to 6,562 ft) above sea level. If you must operate this product above 2,000 m or below sea level, contact Aerotech, Inc.
Pollution	Pollution Degree 2 Typically only nonconductive pollution occurs.
Operation	Use only indoors

1.4. Drive and Software Compatibility

This table shows the available drives and which version of the software first supported each drive. In the **Last Software Version** column, drives that show a specific version number are not supported after that version.

Table 1-5: Drive and Software Compatibility

Drive Type	First Software Version	Last Software Version
Automation1 XC2e	2.0	Current

Chapter 2: Installation and Configuration

Unpacking the Chassis

> **IMPORTANT**: All electronic equipment and instrumentation is wrapped in antistatic material and packaged with desiccant. Ensure that the antistatic material is not damaged during unpacking.

Inspect the container of the XC2e for any evidence of shipping damage. If any damage exists, notify the shipping carrier immediately.

Remove the packing list from the XC2e container. Make sure that all the items specified on the packing list are contained within the package.

The documentation for the XC2e is on the included installation device. The documents include manuals, interconnection drawings, and other documentation pertaining to the system. Save this information for future reference. Additional information about the system is provided on the Serial and Power labels that are placed on the XC2e chassis.

The system serial number label contains important information such as the:

- Customer order number (please provide this number when requesting product support)
- Drawing number
- System part number

2.1. Input Power Connections

The XC2e has two DC input power connectors. One connector is for control power and the other connector is for motor power. For a full list of electrical specifications, refer to Section 1.1. Refer to Section 2.6. for a System Interconnection Drawing.

2.1.1. Control Supply Connector

The Control Supply input supplies power to the communications and logic circuitry of the XC2e . The **+24V** input is connected to an internal fuse. Refer to Table 5-4 for the internal fuse value and part number. For an isolated DC supply, connect **0V** to protective ground at the supply. Use twisted pair wiring to minimize radiated noise emissions (refer to Figure 2-1).

IMPORTANT: Refer to local electrical safety requirements to correctly size external system wires.

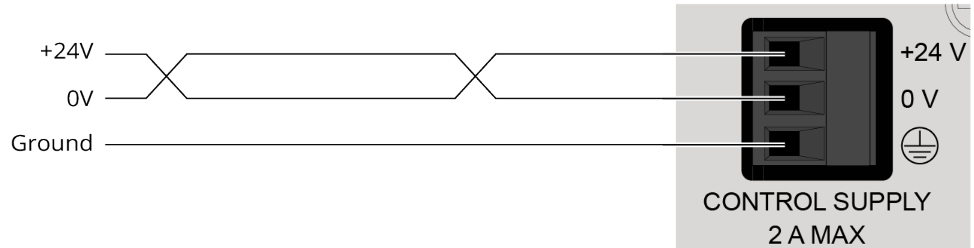


Figure 2-1: Control Supply Connections

Table 2-1: Control Supply Connector Wiring Specifications

Pin	Description	Recommended Wire Size
+24 V	24 VDC (±10%) Control Power Input (2 A max, 0.4 A typical without brake)	0.34 mm² (#22 AWG)
0 V	Control Power Common Input	0.34 mm² (#22 AWG)
⏚	Protective Ground	0.34 mm² (#22 AWG)

Table 2-2: Mating Connector Part Numbers for the Control Supply Connector

Type	Aerotech P/N	Third Party P/N	Screw Torque: N·m	Wire Size: mm² [AWG]
3-Pin Terminal Block	ECK02456	Phoenix 1839610	0.22 - 0.25	2.5 - 0.05 [14-30]

2.1.2. Motor Supply Connector

Motor power is applied to the **DC+** and **0V** terminals of the XC2e Motor Supply connector. The **DC+** input is connected to an internal fuse. Refer to Table 5-4 for the internal fuse value and part number. For an isolated DC supply, connect **0V** to protective ground at the supply. Use twisted pair wiring to minimize radiated noise emissions (refer to Figure 2-2).

> **IMPORTANT**: Refer to local electrical safety requirements to correctly size external system wires.

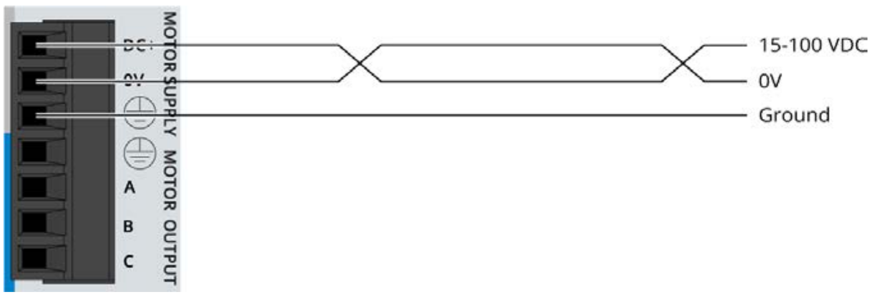


Figure 2-2: Motor Supply Connections

Table 2-3: Motor Supply Connector Wiring Specifications

Pin	Description	Recommended Wire Size
DC+	Motor Power Input (15-100 VDC)	0.5 mm² (#20 AWG)
0 V	Motor Power Input Common	0.5 mm² (#20 AWG)
⏚	Protective Ground	0.5 mm² (#20 AWG)

Table 2-4: Mating Connector Part Numbers for the Motor Supply Connector

Type	Aerotech P/N	Third Party P/N	Screw Torque: Nm	Wire Size: mm²[AWG]
7-Pin Terminal Block	ECK02457	Phoenix 1839678	0.22 - 0.25	2.5 - 0.05 [14-30]

2.1.3. Minimizing Noise for EMC/CE Compliance

IMPORTANT: The XC2e is a component designed to be integrated with other electronics. EMC testing must be conducted on the final product configuration.

To reduce electrical noise, observe the following motor feedback and input power wiring techniques.

1. Use shielded cable for motor and feedback connectors. Connect the shield to the backshell at each end of the cable.
2. Separate motor and power wiring from encoder and I/O wiring.
3. Mount drives, power supplies, and filter components on a conductive panel. Keep wire-run lengths to a minimum. For the AC power lines feeding the VDC Motor supply and VDC Control supply, place a line filter, such as Schaffner FN2070-10-06 (Aerotech# ECZ00284) between the VDC power supply's AC inputs and the AC power source.
4. Use the lowest motor voltage required by the application to reduce radiated emission.
5. Use a separate wire for each ground connection to the drive. Use the shortest possible wire length.

For additional XC2e system interconnection information, refer to Section 2.6. System Interconnection.

2.2. Motor Power Output Connector

DANGER: Before you do maintenance to the equipment, disconnect the electrical power. Wait at least one (1) minute after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.

The XC2e can be used to drive the following motor types:

- Brushless (refer to Section 2.2.1.)
- DC Brush (refer to Section 2.2.2.)
- Stepper (refer to Section 2.2.3.)

For a complete list of electrical specifications, refer to Section 1.1.

IMPORTANT: Refer to local electrical safety requirements to correctly size external system wires.

The 7-pin terminal block style motor output connector is located on the front panel. The pinout for this connector is shown in Table 2-5.

Table 2-5: Motor Power Output Connector Pinout

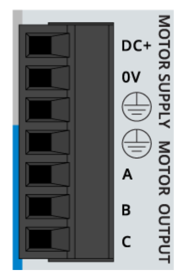
Pin	Description	Recommended Wire Size	Connector
⏚	Earth Ground to Motor	0.5 mm² (#20 AWG)	
A	Brushless Phase A Motor Lead DC Brush + Stepper	0.5 mm² (#20 AWG)	
B	Brushless Phase B Motor Lead Stepper	0.5 mm² (#20 AWG)	
C	Brushless Phase C Motor Lead DC Brush - Stepper Return	0.5 mm² (#20 AWG)	

Table 2-6: Mating Connector Part Numbers for the Motor Power Output Connector

Type	Aerotech P/N	Third Party P/N	Screw Torque: Nm	Wire Size: mm²[AWG]
7-Pin Terminal Block	ECK02457	Phoenix 1839678	0.22 - 0.25	2.5 - 0.05 [14-30]

2.2.1. Brushless Motor Connections

The configuration shown in Figure 2-3 is an example of a typical brushless motor connection.

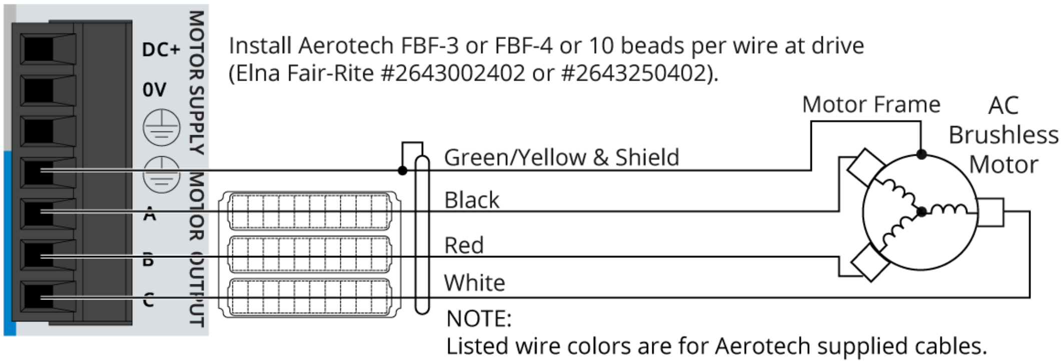


Figure 2-3: Brushless Motor Configuration

Table 2-7: Wire Colors for Aerotech-Supplied Brushless Motor Cables

Pin	Wire Color Set 1 (1)	Wire Color Set 2	Wire Color Set 3	Wire Color Set 4
⏚	Green/Yellow & Shield (2)	Green/Yellow & Shield	Green/Yellow & Shield	Green/Yellow & Shield
A	Black	Blue & Yellow	Black #1	Black & Brown
B	Red	Red & Orange	Black #2	Red & Orange
C	White	White & Brown	Black #3	Violet & Blue

(1) Wire Color Set #1 is the wire set typically used by Aerotech.

(2) "&" indicates two wires (Red & Orange); " / " indicates a single wire (Green/White).

Brushless motors are commutated electronically by the controller. The use of Hall effect devices for commutation is recommended.

The controller requires that the Back-EMF of each motor phase be aligned with the corresponding Hall-effect signal. To ensure proper alignment, motor, Hall, and encoder connections should be verified using one of the following methods: *powered*, through the use of a test program; or *unpowered* using an oscilloscope. Both methods will identify the A, B, and C Hall/motor lead sets and indicate the correct connections to the controller. Refer to Section 2.2.1.1. for powered motor phasing or Section 2.2.1.2. for unpowered motor and feedback phasing.

For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

A motor filter module can be installed between the drive and the motor to reduce the effects on PWM generated noise currents.

2.2.1.1. Brushless Motor Powered Motor and Feedback Phasing

Observe the state of the encoder and Hall-effect device signals in the Diagnostics section of the Status Utility.

Table 2-8: Hall Signal Diagnostics

Hall-Signal Status	Definition
--	0 V or logic low
ON	5 V or logic high

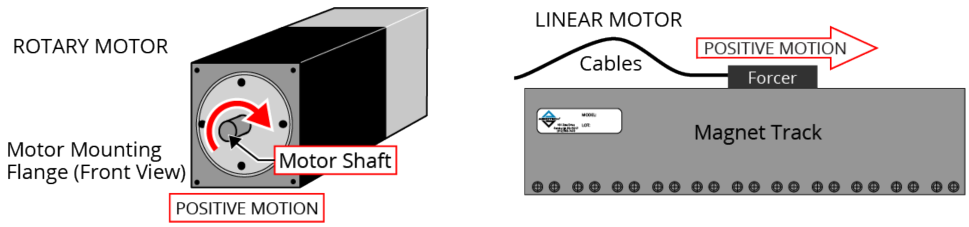


Figure 2-4: Positive Motor Direction

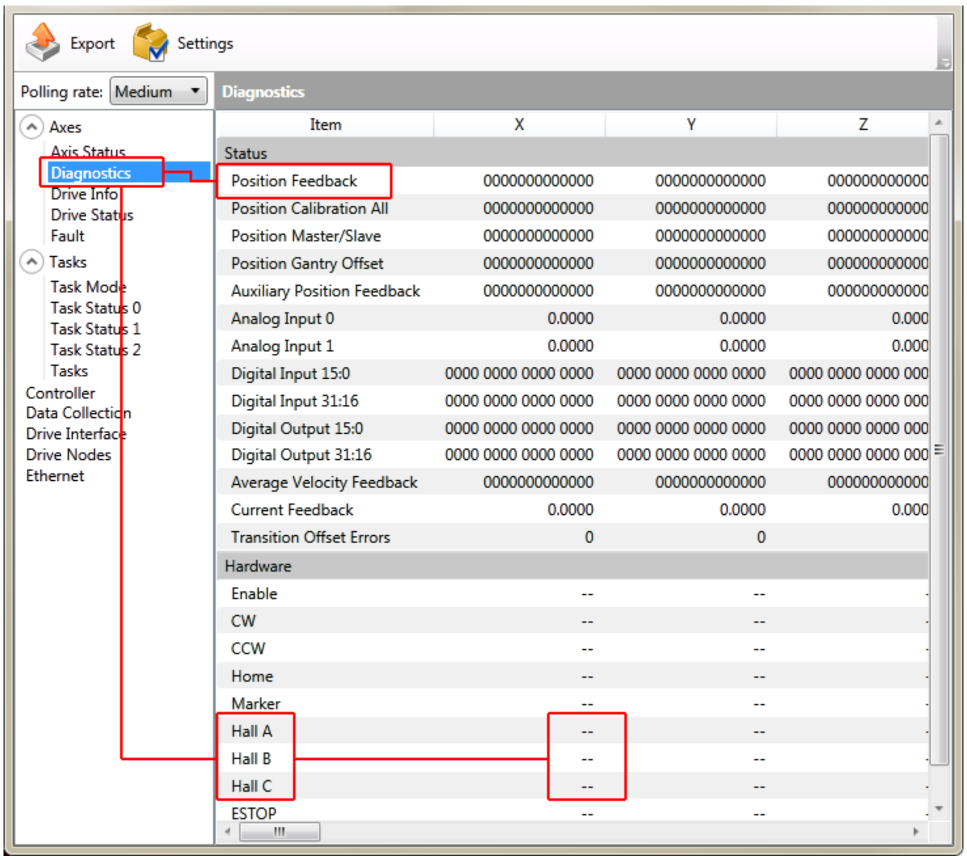


Figure 2-5: Encoder and Hall Signal Diagnostics

2.2.1.2. Brushless Motor Unpowered Motor and Feedback Phasing

Disconnect the motor from the controller and connect the motor in the test configuration shown in Figure 2-6. This method will require a two-channel oscilloscope, a 5V power supply, and six resistors (10,000 ohm, 1/4 watt). All measurements should be made with the probe common of each channel of the oscilloscope connected to a neutral reference test point (TP4, shown in Figure 2-6). Wave forms are shown while moving the motor in the positive direction.

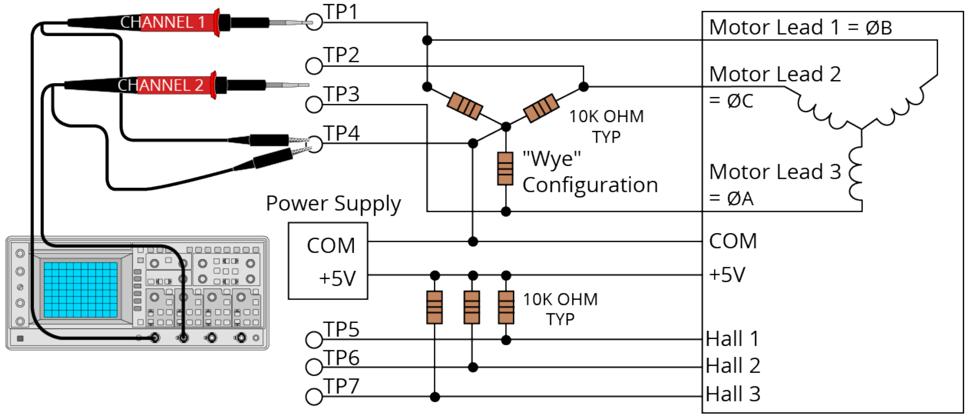


Figure 2-6: Brushless Motor Phasing Oscilloscope Example

With the designations of the motor and Hall leads of a third party motor determined, the motor can now be connected to an Aerotech system. Connect motor lead A to motor connector A, motor lead B to motor connector B, and motor lead C to motor connector C. Hall leads should also be connected to their respective feedback connector pins (Hall A lead to the Hall A feedback pin, Hall B to Hall B, and Hall C to Hall C). The motor is correctly phased when the Hall states align with the Back EMF as shown in (Figure 2-7). Use the CommutationOffset parameter to correct for Hall signal misalignment.

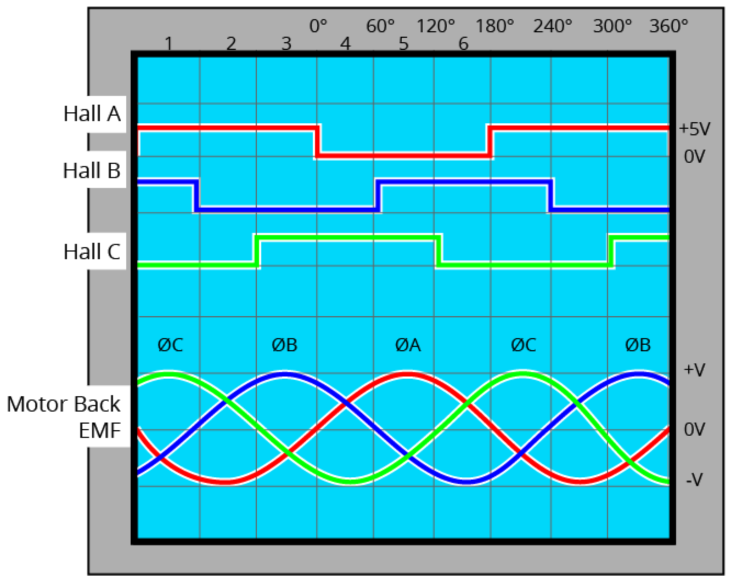


Figure 2-7: Brushless Motor Phasing Goal

2.2.2. DC Brush Motor Connections

The configuration shown in Figure 2-8 is an example of a typical DC brush motor connection. Refer to Section 2.2.2.1. for information on motor phasing.

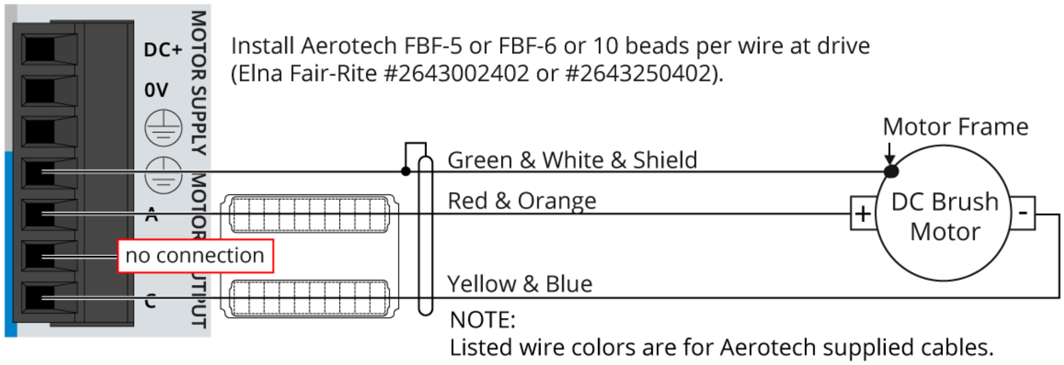


Figure 2-8: DC Brush Motor Configuration

Table 2-9: Wire Colors for Aerotech-Supplied DC Brush Motor Cables

Pin	Wire Color Set 1(1)	Wire Color Set 2	Wire Color Set 3
⏚	Green & White & Shield (2)	Green/Yellow & Shield	Green/Yellow & Shield
A	Red & Orange	Red	Red & Orange
C	Yellow & Blue	Black	Yellow & Blue

(1) Wire Color Set #1 is the typical wire set used by Aerotech.
(2) “&” (Red & Orange) indicates two wires; “ / ” (Green/White) indicates a single wire.

2.2.2.1. DC Brush Motor Phasing

A properly phased motor means that the positive motor lead should be connected to the ØA motor terminal and the negative motor lead should be connected to the ØC motor terminal. To determine if the motor is properly phased, connect a voltmeter to the motor leads of an un-powered motor:

1. Connect the positive lead of the voltmeter to the one of the motor terminals.
2. Connect the negative lead of the voltmeter to the other motor terminal.
3. Move or rotate the motor in the positive or clockwise (CW) direction by hand.

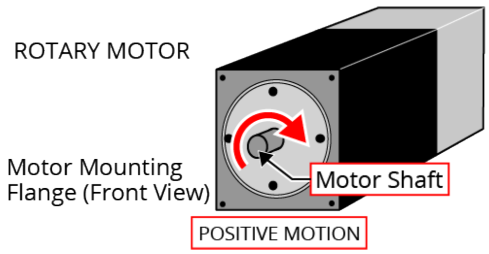


Figure 2-9: Positive Motor Direction

4. If the voltmeter indicates a negative value, swap the motor leads and move the motor by hand in the positive direction, again. When the voltmeter indicates a positive value, the motor leads have been identified.
5. Connect the motor lead from the positive lead of the voltmeter to the ØA motor terminal on the XC2e. Connect the motor lead from the negative lead of the voltmeter to the ØC motor terminal on the XC2e.

For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

2.2.3. Stepper Motor Connections

The configuration shown in Figure 2-10 is an example of a typical stepper motor connection. Refer to Section 2.2.3.1. for information on motor phasing.

In this case, the effective motor voltage is half of the applied bus voltage. For example, an 80V motor bus supply is needed to get 40V across the motor.

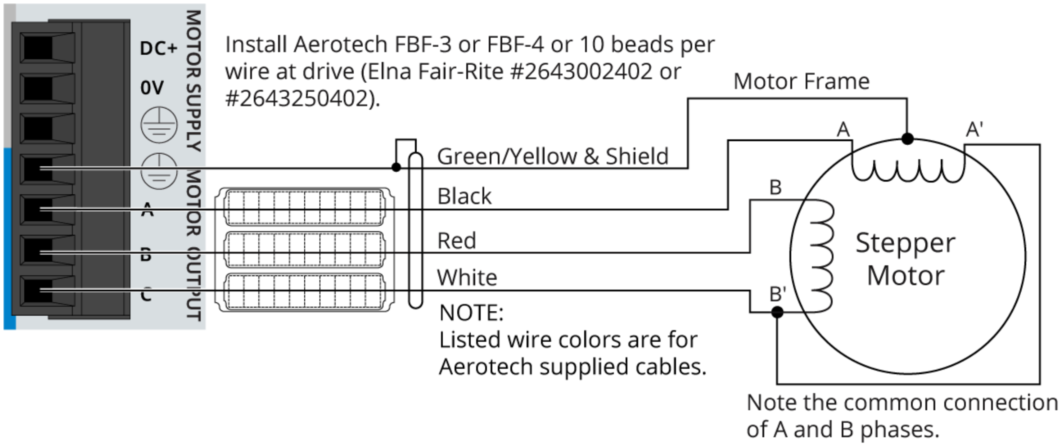


Figure 2-10: Stepper Motor Configuration

Table 2-10: Wire Colors for Aerotech-Supplied Stepper Motor Cables

Pin	Wire Color Set 1(1)	Wire Color Set 2
⏚	Green/Yellow & Shield (2)	Green/Yellow & Shield
A	Black	Brown
B	Red	Yellow
C	White	White & Red
(1) Wire Color Set #1 is the typical wire set used by Aerotech. (2) “&” (Red & Orange) indicates two wires; “ / ” (Green/White) indicates a single wire.		

2.2.3.1. Stepper Motor Phasing

A stepper motor can be run with or without an encoder.

Without an Encoder: You do not need to phase the motor.

With an Encoder: Because the end of travel (EOT) limit inputs are relative to motor rotation, it is important to phase the motor.

Run a positive motion command. The motor is phased correctly if there is a positive scaling factor (determined by the CountsPerUnit parameters) and the motor moves in a clockwise direction when you view the motor from the front mounting flange (Figure 2-11). If the motor moves in a counterclockwise direction, swap the motor leads and re-run the command. After the motor has been phased, if you want to change the direction of positive motion, use the ReverseMotionDirection parameter.

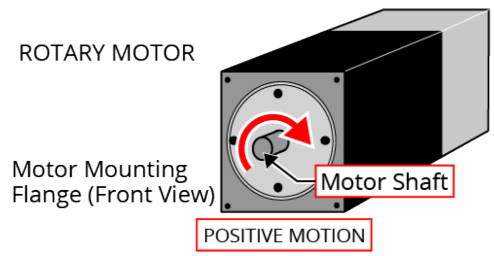


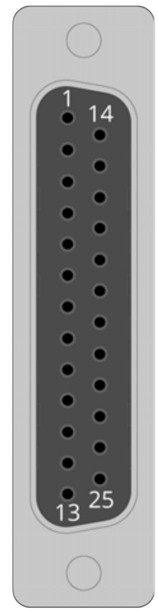
Figure 2-11: Positive Motor Direction

For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

2.3. Feedback Connector

The connector pin assignment is shown in Table 2-11 with detailed connection information in the following sections.

Table 2-11: Feedback Connector Pinout

Pin #	Description	In/Out/Bi	Connector
1	Reserved	N/A	
2	Motor Over Temperature Thermistor	Input	
3	+5V Power (1)	N/A	
4	Plug and Play Serial Data (for Aerotech stages only)	Bidirectional	
5	Hall-Effect Sensor B (brushless motors only)	Input	
6	Encoder Marker Reference Pulse -	Input	
	Absolute Encoder Clock -	Output	
7	Encoder Marker Reference Pulse +	Input	
	Absolute Encoder Clock +	Output	
8	Absolute Encoder Data -	Bidirectional	
9	Reserved	N/A	
10	Hall-Effect Sensor A (brushless motors only)	Input	
11	Hall-Effect Sensor C (brushless motors only)	Input	
12	Clockwise End of Travel Limit	Input	
13	Brake Output -	Output	
14	Encoder Cosine +	Input	
15	Encoder Cosine -	Input	
16	+5V Power (1)	N/A	
17	Encoder Sine +	Input	
18	Encoder Sine -	Input	
19	Absolute Encoder Data+	Bidirectional	
20	Signal Common	N/A	
21	Signal Common	N/A	
22	Home Switch Input	Input	
23	Encoder Fault Input	Input	
24	Counterclockwise End of Travel Limit	Input	
25	Brake Output +	Output	

(1) The maximum combined current output is 500 mA.

Table 2-12: Mating Connector Part Numbers for the Feedback Connector

Mating Connector	Aerotech P/N	Third Party P/N
25-Pin D-Connector	ECK00101	FCI DB25P064TXLF
Backshell	ECK00656	Amphenol 17E-1726-2

2.3.1. Primary Encoder Inputs

The primary encoder inputs are accessible through the Feedback connector. Use the PrimaryFeedbackType parameter to configure the XC2e to accept an encoder signal type.

Square Wave encoder signals: Section 2.3.1.1.

Absolute encoder signals: Section 2.3.1.2.

Sine Wave encoder signals (as permitted by the multiplier option): Section 2.3.1.3.

Refer to Section 2.3.1.4. for encoder feedback phasing.

Refer to Section 3.2. for the auxiliary encoder input on the AUX connector.

Table 2-13: Multiplier Options

Option	Primary Encoder Accepts...	Auxiliary Encoder Accepts...
-MX0	Square Wave or Absolute encoders	Square Wave encoders
-MX2	Sine Wave (high performance), Square Wave, or Absolute encoders	Square Wave encoders
-MX3	Sine Wave (high performance), Square Wave, or Absolute encoders	Sine Wave (standard performance) or Square Wave encoders

IMPORTANT: Physically isolate the encoder wiring from motor, AC power, and all other power wiring

Table 2-14: Primary Encoder Input Pins on the Feedback Connector

Pin #	Description	In/Out/Bi
3	+5V Power (1)	N/A
6	Encoder Marker Reference Pulse -	Input
	Absolute Encoder Clock -	Output
7	Encoder Marker Reference Pulse +	Input
	Absolute Encoder Clock +	Output
8	Absolute Encoder Data -	Bidirectional
14	Encoder Cosine +	Input
15	Encoder Cosine -	Input
16	+5V Power (1)	N/A
17	Encoder Sine +	Input
18	Encoder Sine -	Input
19	Absolute Encoder Data+	Bidirectional
20	Signal Common	N/A
21	Signal Common	N/A
(1) The maximum combined current output is 500 mA.		

2.3.1.1. Square Wave Encoder

The XC2e accepts RS-422 square wave encoder signals. The XC2e will generate a feedback fault if it detects an invalid signal state caused by an open or shorted signal connection. Use twisted-pair wiring for the highest performance and noise immunity.

Table 2-15: Square Wave Encoder Specifications

Specification	Value
Encoder Frequency	10 MHz maximum (25 ns minimum edge separation)
x4 Quadrature Decoding	40 million counts/sec

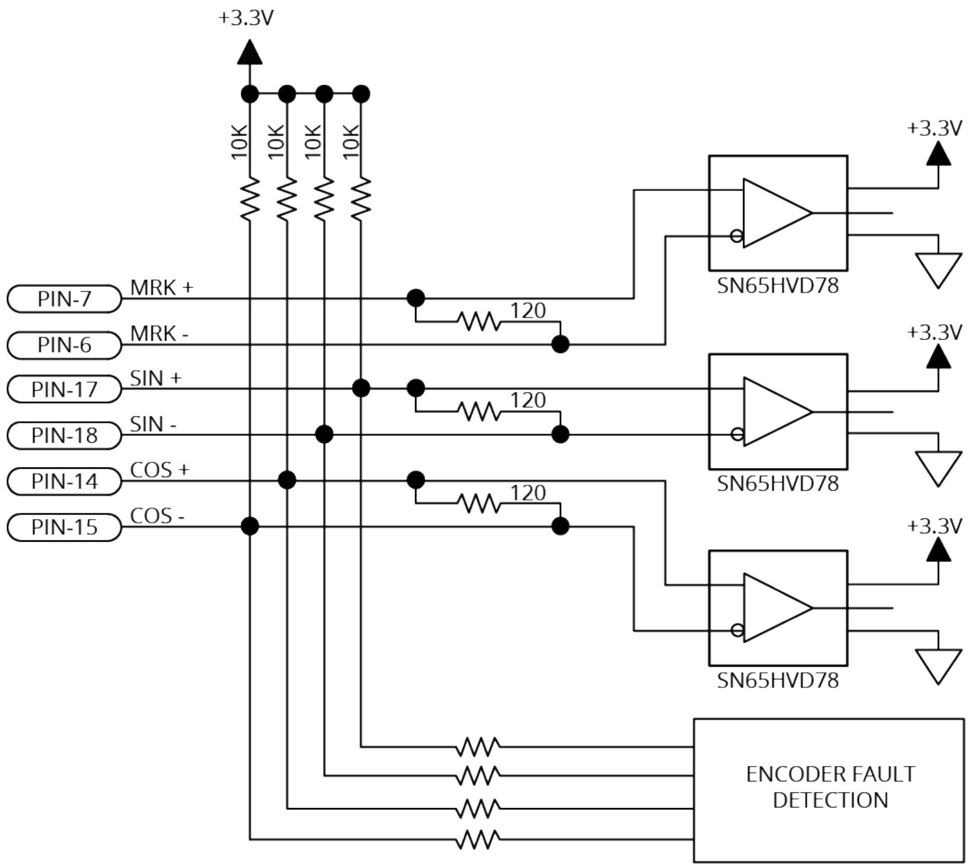


Figure 2-12: Square Wave Encoder Schematic (Feedback Connector)

2.3.1.2. Absolute Encoder

The XC2e retrieves absolute position data along with encoder fault information through a serial data stream from the absolute encoder. Use twisted-pair wiring for the highest performance and noise immunity. You cannot echo an absolute encoder signal.

Refer to Figure 2-13 for the serial data stream interface.

Refer to the Help file for information on how to set up your EnDat or BiSS absolute encoder parameters.

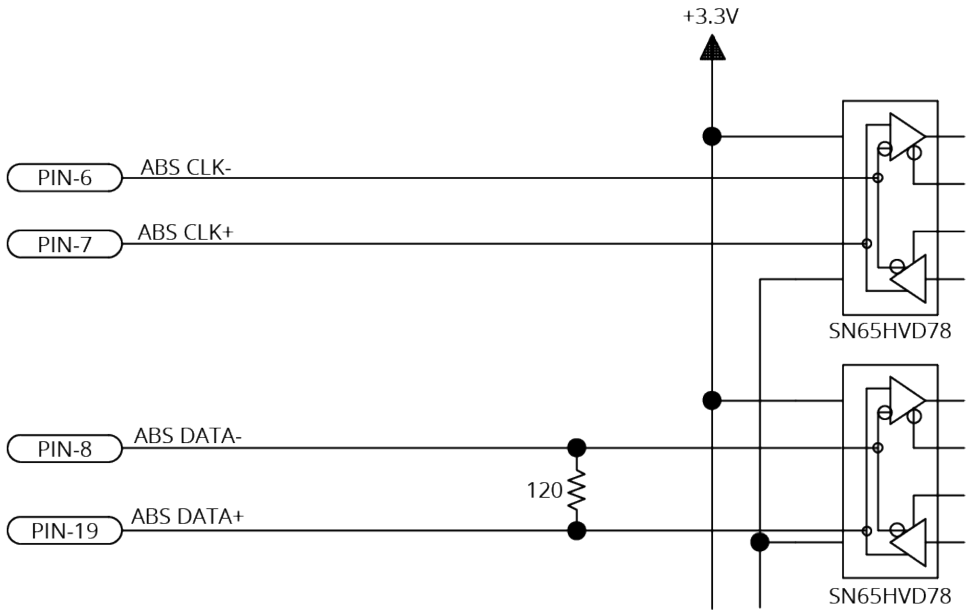


Figure 2-13: Absolute Encoder Schematic (Feedback Connector)

2.3.1.3. Sine Wave Encoder [-MX2/-MX3 Option]

The Sine Wave Encoder option provides higher positioning resolution by subdividing the fundamental output period of the encoder into smaller increments. The amount of subdivision is specified by the PrimaryEncoderMultiplicationFactor parameter. Use Encoder Tuning to adjust the value of the gain, offset, and phase balance controller parameters to get the best performance. For more information, refer to the Help file.

High resolution or high-speed encoders can require increased bandwidth for correct operation. Use the High Speed Mode of the PrimaryEncoderMultiplierSetup parameter to enable the high bandwidth mode. Because this mode increases sensitivity to system noise, use it only if necessary. This option is only available on the Primary encoder input.

The XC2e can generate emulated encoder signals. These signals can be output on the Auxiliary Encoder (AUX) connector or used internally by the PSO. Refer to the EncoderDivider and PrimaryEmulatedQuadratureDivider parameters and the encoder output functions in the Help file for more information.

For the highest performance, use twisted pair double-shielded cable with the inner shield connected to signal common and the outer shield connected to frame ground. Do not join the inner and outer shields in the cable.

Table 2-16: Sine Wave Encoder Specifications

Specification		Value	
		Primary	Auxiliary
Input Frequency (max)		200 kHz, 2 MHz	200 kHz
Input Amplitude (1)		0.6 to 1.75 Vpk-pk	
Interpolation Factor (max)	-MX2	65,536	N/A
	-MX3	65,536	16,384
-MX2/-MX3 Primary Encoder Channel Interpolation Latency		800 nsec (analog input to quadrature output)	
Input Common Mode		1.5 to 3.5 VDC	
(1) Measured as SIN(+) - SIN(-) or COS(+) - COS(-)			

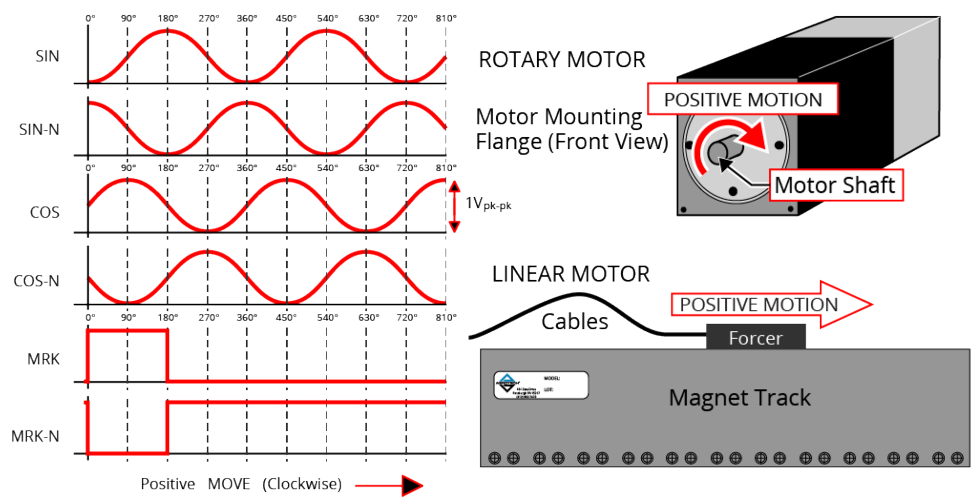


Figure 2-14: Sine Wave Encoder Phasing Reference Diagram

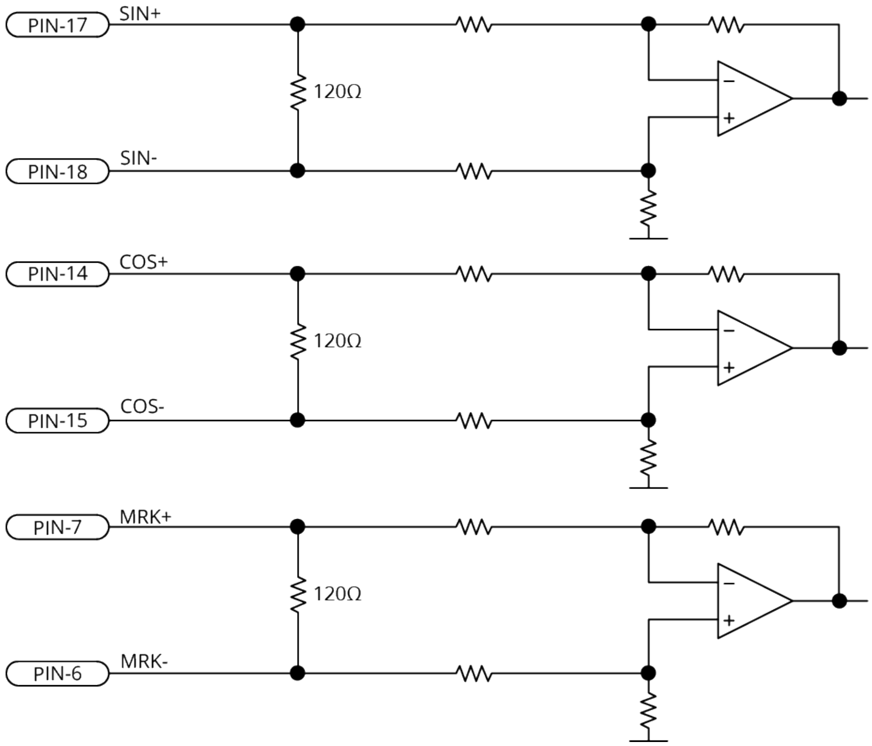


Figure 2-15: Sine Wave Encoder Schematic (Feedback Connector)

2.3.1.4. Encoder Phasing

Incorrect encoder polarity will cause the system to fault when enabled or when a move command is issued. Figure 2-16 illustrates the proper encoder phasing for clockwise motor rotation (or positive forcer movement for linear motors). To verify, move the motor by hand in the CW (positive) direction while observing the position of the encoder in the diagnostics display (see Figure 2-17).

For dual loop systems, the velocity feedback encoder is displayed in the diagnostic display (Figure 2-17).

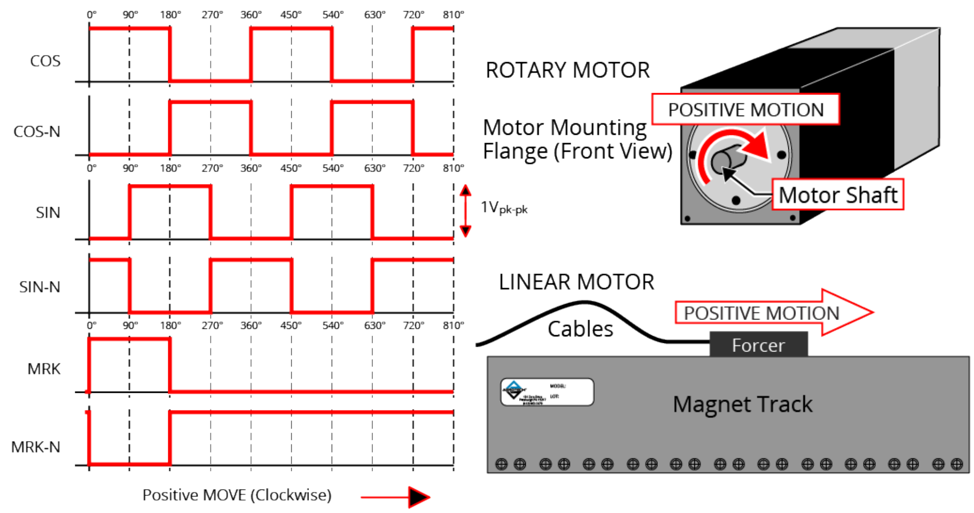


Figure 2-16: Encoder Phasing Reference Diagram (Standard)

IMPORTANT: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-16.

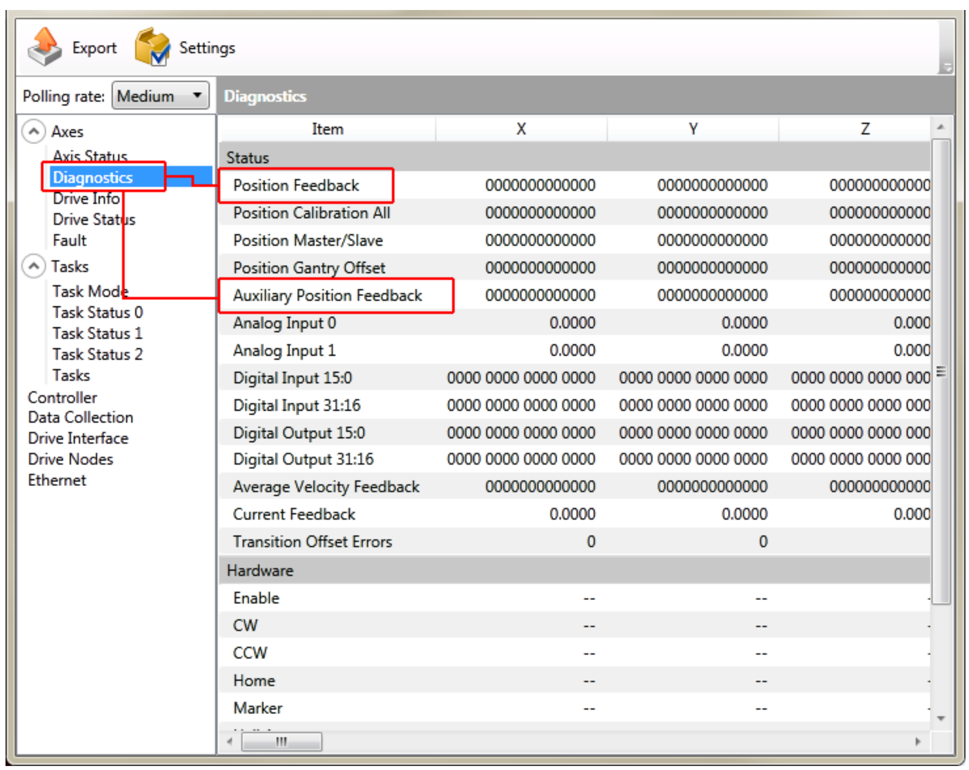


Figure 2-17: Position Feedback in the Diagnostic Display

2.3.2. Hall-Effect Inputs

The Hall-effect switch inputs are recommended for AC brushless motor commutation but not absolutely required. The Hall-effect inputs accept 5 VDC level signals. Hall states (0,0,0) or (1,1,1) are invalid and will generate a "Hall Fault" axis fault.

Refer to Section 2.2.1.1. for Hall-effect device phasing.

Table 2-17: Hall-Effect Feedback Pins on the Feedback Connector

Pin #	Description	In/Out/Bi
3	+5V Power (1)	N/A
5	Hall-Effect Sensor B (brushless motors only)	Input
10	Hall-Effect Sensor A (brushless motors only)	Input
11	Hall-Effect Sensor C (brushless motors only)	Input
16	+5V Power (1)	N/A
20	Signal Common	N/A
21	Signal Common	N/A
(1) The maximum combined current output is 500 mA.		

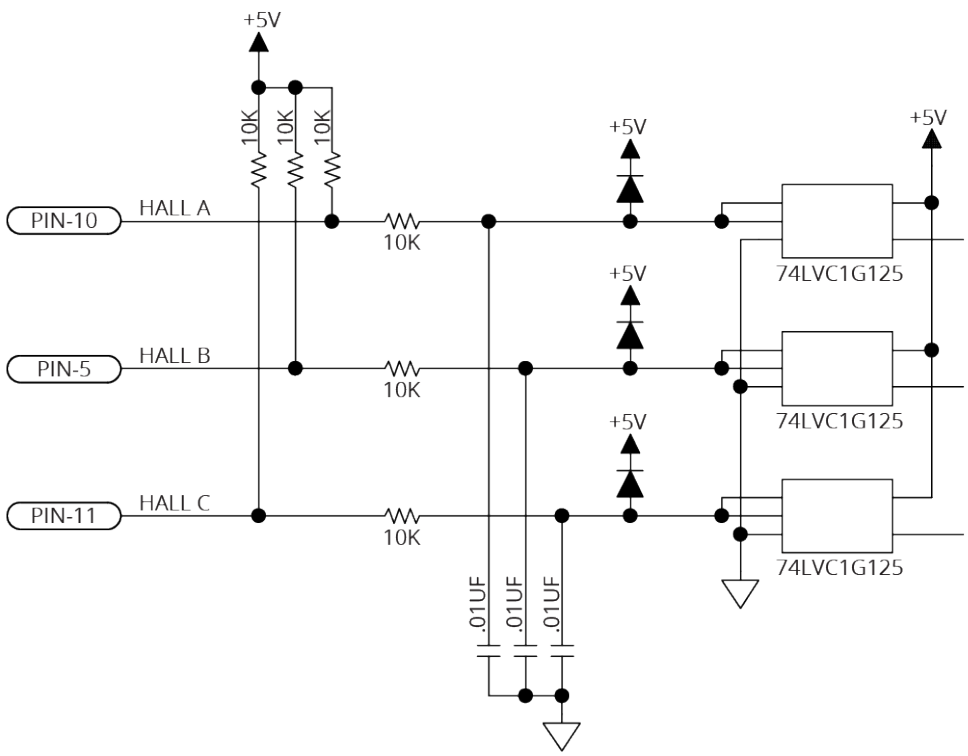


Figure 2-18: Hall-Effect Inputs Schematic (Feedback Connector)

2.3.3. Thermistor Input

The thermistor input is used to detect a motor over temperature condition by using a positive temperature coefficient sensor. As the temperature of the sensor increases, so does the resistance. Under normal operating conditions, the resistance of the thermistor is low which will result in a low input signal. As the increasing temperature causes the thermistor's resistance to increase, the sensor will trigger an over temperature fault.

The thermistor is connected between Pin 2 and Signal Common. The nominal trip value of the sensor is 1.385 kΩ. The circuit includes a 12 kΩ internal pull-up resistor which corresponds to a trip voltage of +0.52 V.

Table 2-18: Thermistor Input Pin on the Feedback Connector

Pin #	Description	In/Out/Bi
2	Motor Over Temperature Thermistor	Input

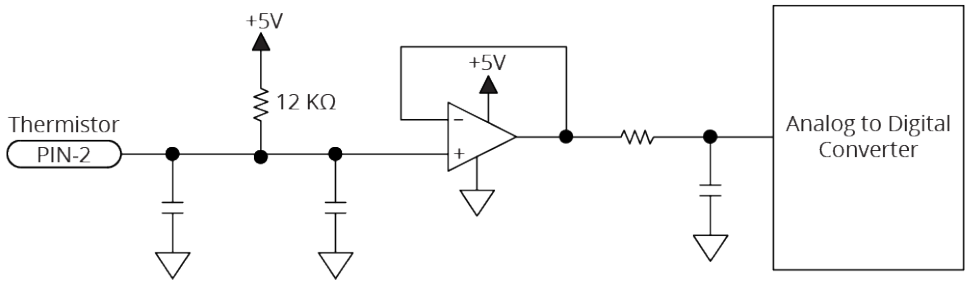


Figure 2-19: Thermistor Input Schematic (Feedback Connector)

2.3.4. Encoder Fault Input

The encoder fault input is for use with encoders that have a fault output. This is provided by some manufactures and indicates a loss of encoder function. The active state of this input is parameter configurable and the controller should be configured to disable the axis when the fault level is active. The nominal trip voltage of the encoder fault input is +2.5 V.

Table 2-19: Encoder Fault Input Pin on the Feedback Connector

Pin #	Description	In/Out/Bi
23	Encoder Fault Input	Input

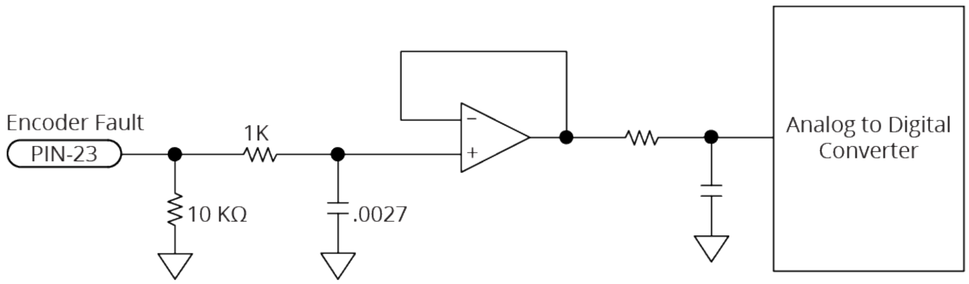


Figure 2-20: Encoder Fault Input Schematic (Feedback Connector)

2.3.5. End of Travel and Home Limit Inputs

End of Travel (EOT) limits are required to define the end of the physical travel on linear axes. Positive or clockwise motion is stopped by the clockwise (CW) end of travel limit input. Negative or counterclockwise motion is stopped by the counterclockwise (CCW) end of travel limit input. The Home Limit switch can be parameter configured for use during the home cycle, however, the CW or CCW EOT limit is typically used instead. All of the end-of-travel limit inputs accept 0-5 VDC level signals. Limit directions are relative to the encoder polarity in the diagnostics display (refer to Figure 2-23).

Table 2-20: End of Travel and Home Limit Pins on the Feedback Connector

Pin #	Description	In/Out/Bi
12	Clockwise End of Travel Limit	Input
16	+5V Power	N/A
20	Signal Common	N/A
21	Signal Common	N/A
22	Home Switch Input	Input
24	Counterclockwise End of Travel Limit	Input

The active state (High/Low) of the EOT limits is software selectable (by the EndOfTravelLimitSetup axis parameter). Figure 2-21 shows the possible wiring configurations for normally-open and normally-closed switches and the parameter setting to use for each configuration.

IMPORTANT: Use NPN-type normally-closed limit switches (Active High) to provide fail-safe behavior in the event of an open circuit.

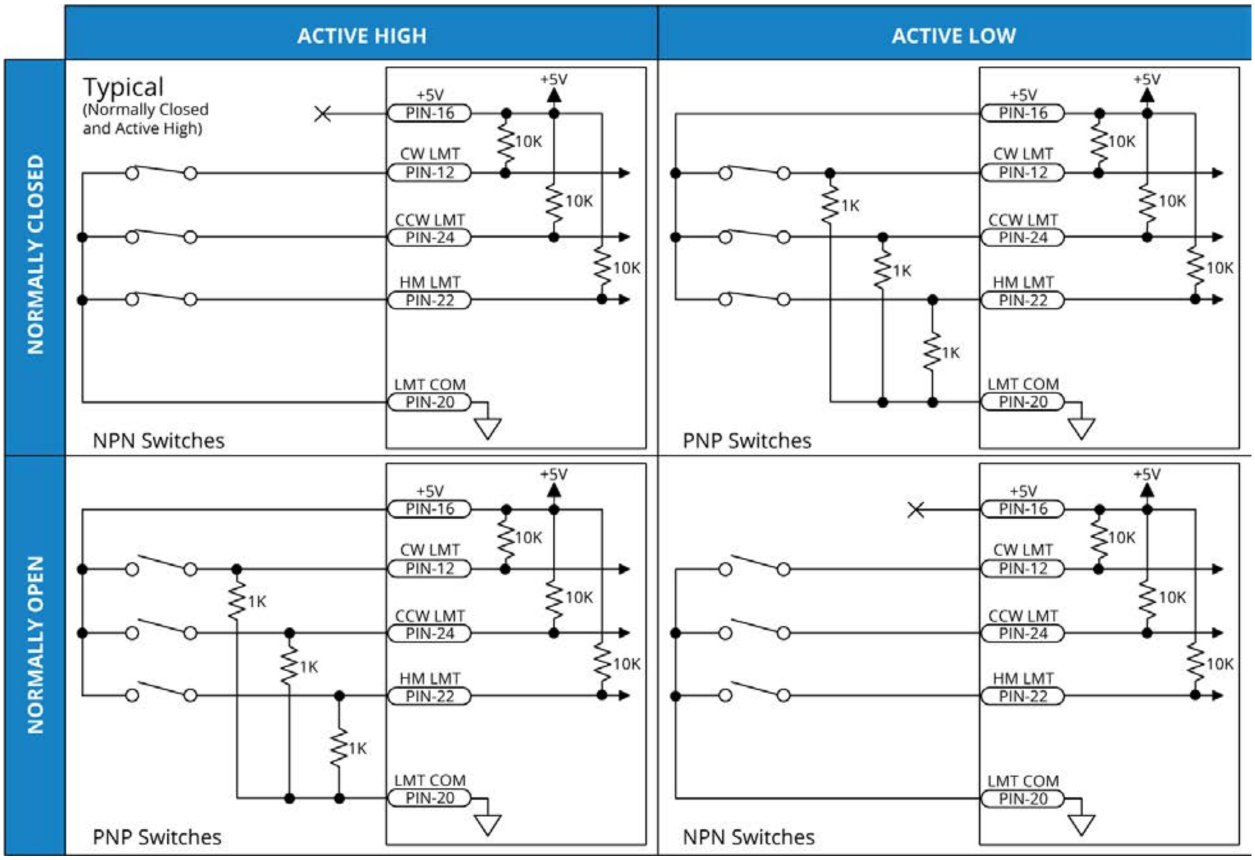


Figure 2-21: End of Travel and Home Limit Input Connections

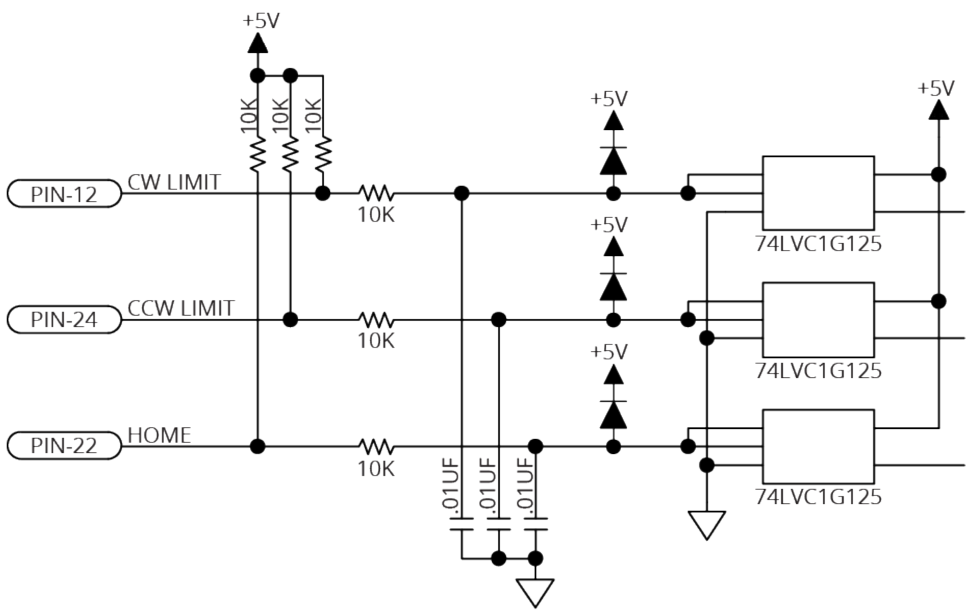


Figure 2-22: End of Travel and Home Limit Input Schematic (Feedback Connector)

2.3.5.1. End of Travel and Home Limit Phasing

If the EOT limits are reversed, you will be able to move further into a limit but be unable to move out. To correct this, swap the connections to the CW and CCW inputs at the Feedback connector or swap the CW and CCW limit functionality in the software using the EndOfTravelLimitSetup parameter. View the logic level of the EOT limit inputs in the Diagnostics display (shown in Figure 2-23).

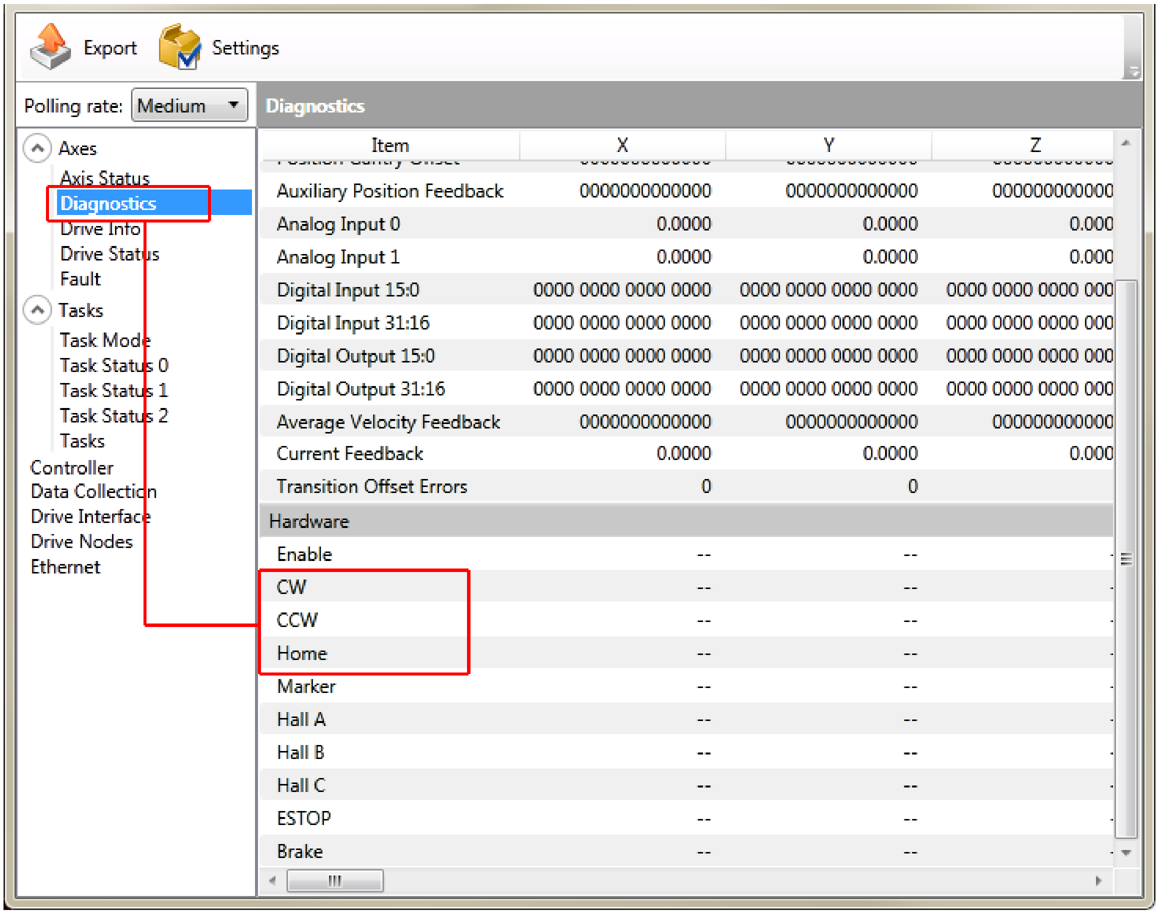


Figure 2-23: End of Travel and Home Limit Input Diagnostic Display

2.3.6. Brake Outputs

The XC2e has a dedicated brake control circuit. Configure the brake with the BrakeSetup parameter for automatic control (typical). You can also use software commands to directly control the brake output.

Table 2-21: Brake Output Pins on the Feedback Connector

Pin #	Description	In/Out/Bi
13	Brake Output -	Output
25	Brake Output +	Output

Table 2-22: Brake Control Specifications

Specification	Value
Maximum Voltage	24 VDC
Maximum Current	1 A

A varistor must be connected across the brake to minimize voltage transients.

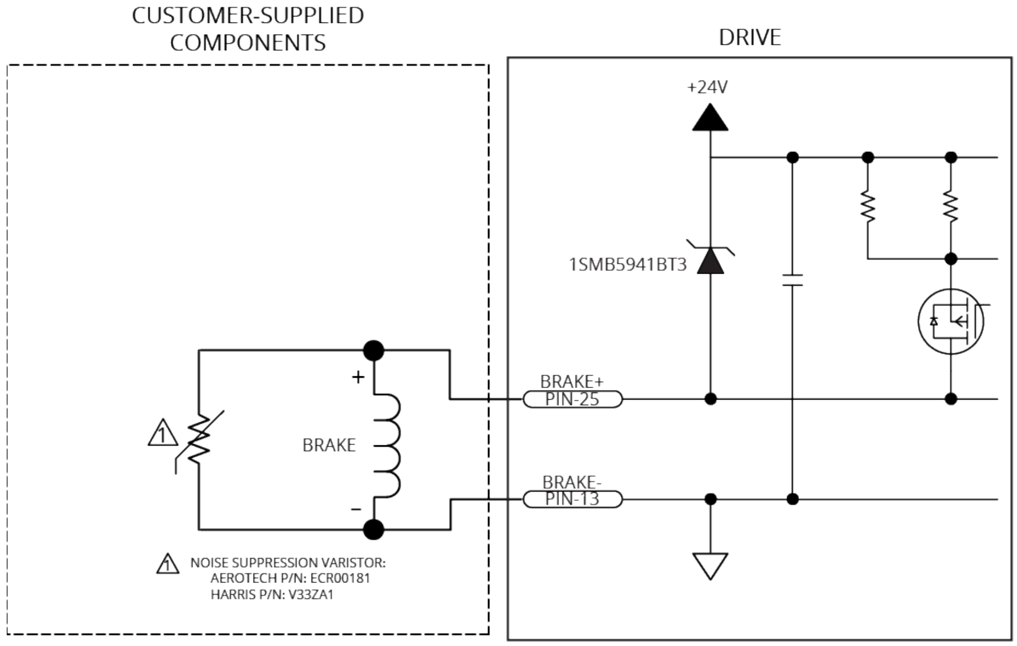


Figure 2-24: Brake Connected to the 25-Pin Feedback Connector (Typical)

2.4. Safe Torque Off Input (STO)

The STO circuit is comprised of two identical channels, each of which must be energized in order for the XC2e to produce motion. Each STO input is opto-isolated and accepts 24V levels directly without the need for external current limiting resistors.

IMPORTANT: The XC2e might be equipped with an STO bypass circuit board. The bypass circuit board defeats the STO safety circuit and allows the system to run at all times. To use the STO safety functionality, remove the circuit board and make connections as outlined in this section.

IMPORTANT: The application circuit and its suitability for the desired safety level is the sole responsibility of the user of the XC2e.

WARNING: STO wires must be insulated to prevent short circuits between connector pins. The primary concern is a short circuit between STO 1 IN and STO 2 IN wire strands.

Table 2-23: STO Connector Pinout

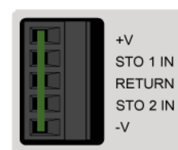
Pin #	Signal	Description	In/Out/Bi	Connector
1	Power Supply +	Used to defeat STO by connecting to STO 1 IN and STO 2 IN	N/A	
2	STO 1 IN	STO Channel 1 Positive Input	Input	
3	RETURN	STO Negative Input	Input	
4	STO 2 IN	STO Channel 2 Positive Input	Input	
5	Power Supply -	Used to defeat STO by connecting to RETURN	N/A	

Table 2-24: Mating Connector Part Numbers for the STO Connector

Description	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: AWG [mm^2]
5-Pin Terminal Block	ECK02393	1827622	0.22 - 0.25	2.5 - 0.05 [14-30]

Table 2-25: STO Electrical Specifications

Status	Value
STO off (motion allowed)	18-24 V, 7 ma
STO on (safe state entered, no motion)	0-6 V
Recommended Wire Gauge	22-26 AWG (0.5 - 0.14 mm^2)
STO System Power Supply	PELV
STO Wire Length (maximum)	50 m

Figure 2-25 shows one safety device connected to multiple XC2es in parallel.

WARNING: The XC2e does not check for short circuits on the external STO wiring. If this is not done by the external safety device, short circuits on the wiring must be excluded. Refer to EN ISO 13849-2. For Category 4 systems, the exclusion of short circuits is mandatory.

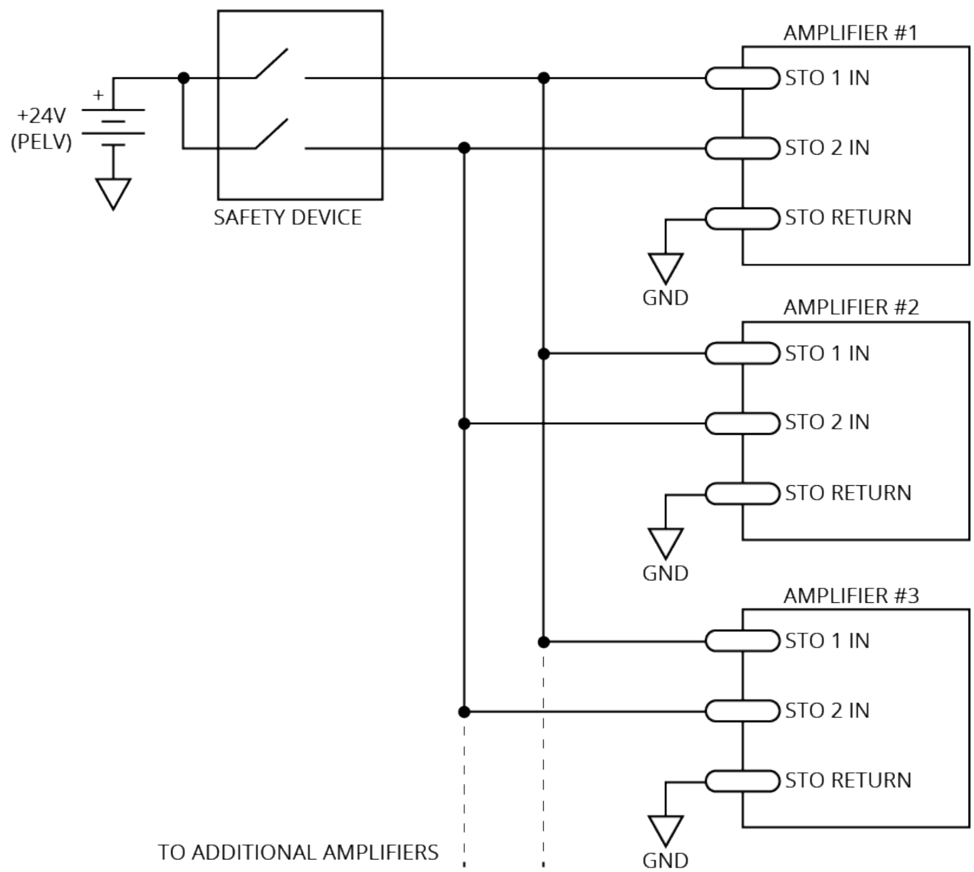


Figure 2-25: Typical Configuration

2.4.1. STO Standards

Table 2-26 describes and specifies the safety requirements at the system level for the Safe Torque Off (STO) feature of the XC2e. This assumes that diagnostic testing is performed according to Section 2.4.4. and Table 2-27.

Table 2-26: STO Standards

Standard	Maximum Achievable Safety
EN/IEC 61800-5- 2:2016	SIL 3
EN/IEC 61508-1:2010	SIL 3
EN/IEC 61508-2:2010	SIL 3
EN ISO 13849-1:2015	Category 4, PL e
EN/IEC 62061:2005 with Amendments	SIL 3

Table 2-27: STO Standards Data

Standard	Value
EN ISO 13849-1:2015	$MTTF_D$ > 1000 years, DC_{AVG} 99% Maximum PL e, Category 4
EN ISO 13849-1:2015 EN/IEC 61508	Lifetime = 20 years No proof test required Interval for manual STO test: • Once per year for SIL2/PL d/category 3 • Once per three months for SIL3/PL e/category 3 • Once per day for SIL3/PL e/category 4
EN/IEC 61508	SIL3 PFH < 3 FIT SFF > 99%

2.4.2. STO Functional Description

The motor can only be activated when voltage is applied to both STO 1 and STO 2 inputs. The STO state will be entered if power is removed from either the STO 1 or the STO 2 inputs. When the STO state is entered, the motor cannot generate torque or force and is therefore considered safe.

The STO function is implemented with two redundant channels in order to meet stated performance and SIL levels. STO 1 disconnects the high side power amplifier transistors and STO 2 disconnects the low side power amplifier transistors. Disconnecting either set of transistors effectively prevents the XC2e from being able to produce motion.

The XC2e software monitors each STO channel and will generate an Emergency Stop software fault when either channel signals the stop state. Each STO channel contains a fixed delay which allows the XC2e to perform a controlled stop before the power amplifier transistors are turned off.

A typical configuration requiring a controlled stop has the Emergency Stop Fault mask bit set in the FaultMask, FaultMaskDecel, and FaultMaskDisable parameters. This stops the axis using the rate specified by the AbortDecelRate parameter. The software will disable the axis as soon as the deceleration ramp is complete. This is typically configured to occur before the STO channel turns off the power amplifier transistors.

The software controlled stop functionality must be excluded when considering overall system safety. This is because the software is not safety rated and cannot be included as part of the safety function.

The XC2e will tolerate short diagnostic pulses on the STO 1+ and STO 2+ inputs. The parameter "STOPulseFilter" specifies the maximum pulse width that the XC2e will ignore.

To resume normal operation, apply power to both STO 1 and STO 2 inputs and use the *Acknowledge All* button or the AcknowledgeAll() or FaultAcknowledge() function to clear the Emergency Stop software fault. The recommended use of the Emergency Stop Fault fault mask bits prevent the system from automatically restarting.

You can achieve longer delay times through the use of an external delay timer, such as the Omron G9SA-321 Safety Relay Unit. Place this device between the system ESTOP wiring and the XC2e's STO inputs. Connect the ESTOP signal directly to a digital input, in addition to the external timer, to allow the XC2e to begin a software-controlled stop as soon as the ESTOP signal becomes active. Use the EmergencyStopFaultInput parameter to configure a digital input as an ESTOP input.

Non-standard STO delay times are provided by special factory order. In this case, the non-standard STO delay time is indicated by a label placed on the slice amplifier's main connector (STO DELAY = xx sec).

Table 2-28: STO Signal Delay

	Value
STO Time Delay	450-550 msec

Table 2-29: Motor Function Relative to STO Input State

STO 1	STO 2	Motor Function
Unpowered	Unpowered	No force/torque
Unpowered (1)	Powered (1)	No force/torque
Powered (1)	Unpowered (1)	No force/torque
Powered	Powered	Normal Operation

1. This is considered a Fault Condition since STO 1 and STO 2 do not match. Refer to Section 2.4.4.

2.4.3. STO Startup Validation Testing

Verify the state of the STO 1 and STO 2 channels by manually activating the external STO hardware. Each STO channel must be tested separately in order to detect potential short circuits between the channels. The current state of the STO 1 and STO 2 inputs is shown in the Status Utility. A "–" indicates that the STO input is powered by a high voltage level (24 V). An "ON" indicates that the voltage source has been removed from the input (open circuit or 0 V), and that the STO channel is in the safe state.

DANGER: The STO circuit does not remove lethal voltage from the motor terminals. AC mains power must be removed before servicing.

2.4.4. STO Diagnostics

Activation of STO means removing power from the XC2e's STO inputs. This is typically done by pressing the emergency stop switch. The XC2e initiates a diagnostic check every time the STO is activated after the Diagnostic Test Delay Time has elapsed. The diagnostic check verifies that each channel has entered the safe state. The XC2e is held in the safe state if it determines that one of the channels has not properly entered the safe state. An open circuit or short to 24 V in either STO channel will result in this condition (refer to Section 2.4.3.). The Status Utility screen can be used to verify the levels of the STO input signals while trouble shooting.

In order to meet the listed SIL level, the STO circuit must be activated (power removed from both inputs) according to the interval specified in Table 2-27.

Table 2-30: STO Timing

Time	Description	Value
T1	STO Delay Time (STO input active to motor power off)	450-550 msec
T2	STO deactivated to motor power on (the software is typically configured so that the motor does not automatically re-energize).	< 1 msec
T3	Diagnostic Test Delay Time	550-610 msec

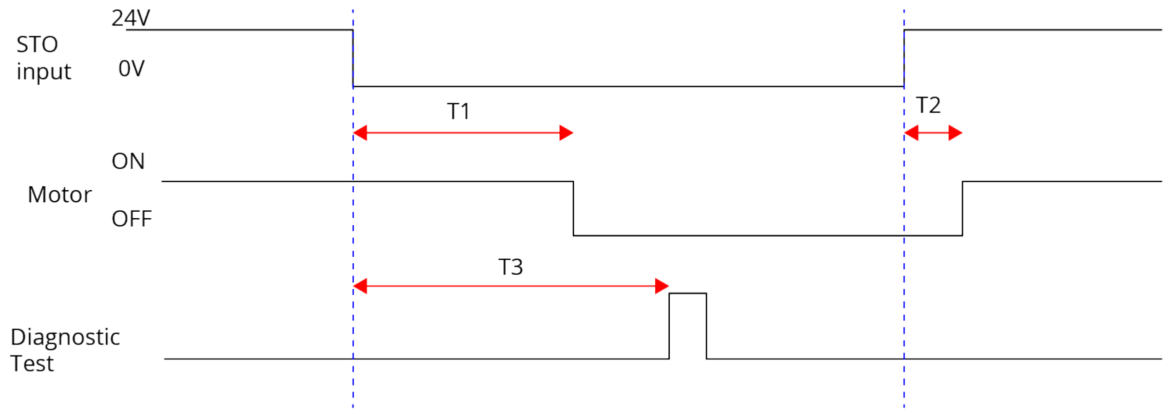


Figure 2-26: STO Timing

The software is typically configured to execute a controlled stop when the STO state is first detected. If power is reapplied to the STO inputs before the STO Delay Time, an STO hardware shutdown will not occur but a software stop may, depending on the width of the STO pulse. The controller will ignore STO active pulses shorter in length than the STOPulseFilter parameter setting.

2.5. HyperWire Interface

The HyperWire bus is the high-speed communications connection from the controller. It operates at 2 gigabits per second. The controller sends all command and configuration information through the HyperWire bus.

HyperWire cables can be safely connected to or disconnected from a HyperWire port while the PC and/or drive is powered on. However, any changes to the HyperWire network topology will disrupt communication and you must reset the controller to re-establish communication.

WARNING: Do not connect or disconnect HyperWire cables while you are loading firmware or damage to the drives may occur.

Table 2-31: HyperWire Card Part Number

Part Number	Description
HYPERWIRE-PCIE	HyperWire adapter, PCIe x4 interface

Table 2-32: HyperWire Cable Part Numbers

Part Number	Description
HYPERWIRE-AO10-5	HyperWire cable, active optical, 0.5 m
HYPERWIRE-AO10-10	HyperWire cable, active optical, 1.0 m
HYPERWIRE-AO10-30	HyperWire cable, active optical, 3.0 m
HYPERWIRE-AO10-50	HyperWire cable, active optical, 5.0 m
HYPERWIRE-AO10-200	HyperWire cable, active optical, 20.0 m

2.6. System Interconnection

Click on the image below to open a separate pdf window with a larger view of the drawing.

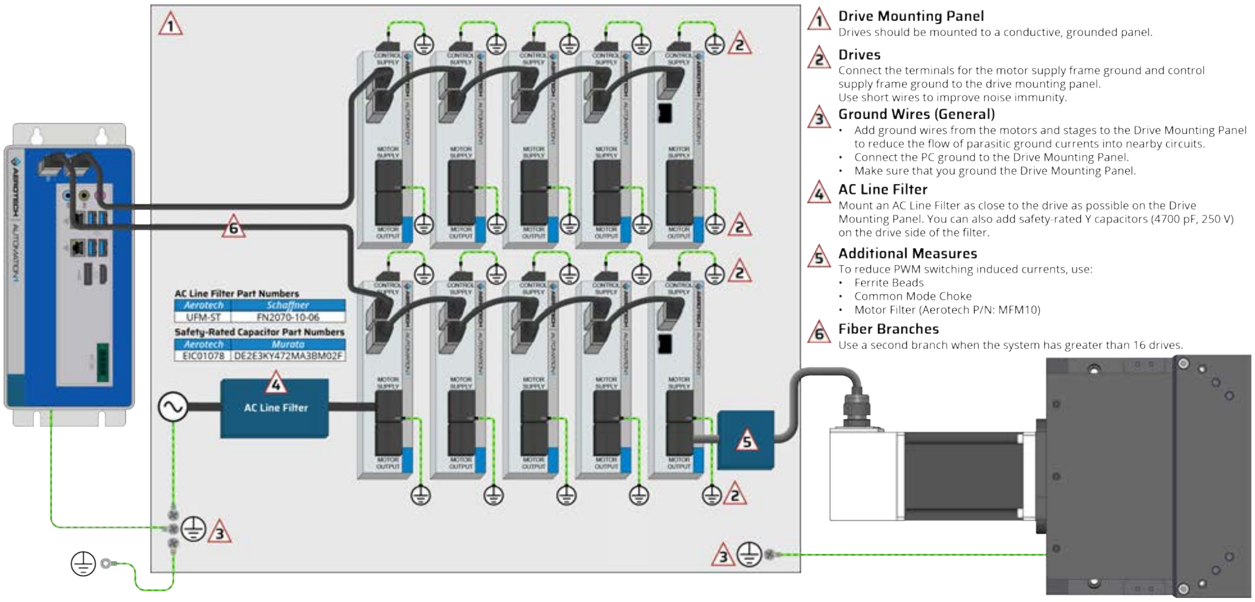
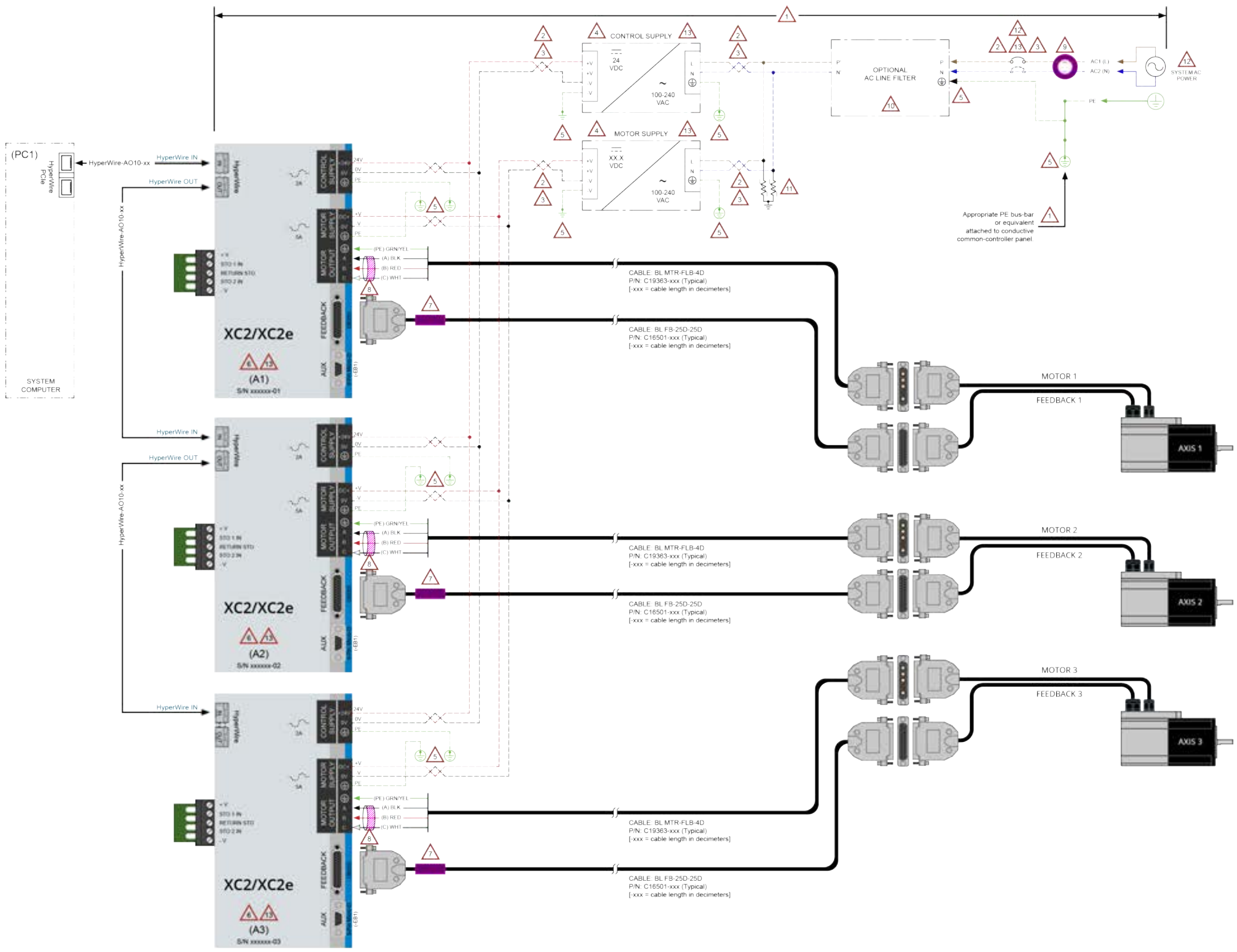


Figure 2-27: System Wiring Drawing (Best Practice)



! ATTENTION !

The system integrator or end user is responsible for all safety compliance and technical requirements for the system wiring.

IMPORTANT: Read all parts of this manual before you install or operate the XLSe or before you do maintenance to your system.
- To prevent injury to you and damage to the equipment, obey the precautions in this manual.
- If you do not understand the information in this manual, contact Aerotech Global Technical Support.

1. For EMC performance, mount all system components on to a common conductive metal panel.
   - Do not use a panel that has a painted or non-conductive coat applied.
   - You can use a panel with a conductive surface coat.
2. System Wiring: ROUTING
   - Separate VAC and VDC wires
   - Separate Motor Supply from Control Supply, Low-Voltage I/O, and Control and Feedback signal wires
   - Separate motor and cable wiring from Control Supply, Low-Voltage I/O, and Control and Feedback signal wires, and VAC/VDC supply wires.
3. System Wiring: SPECIFICATIONS
   - Aerotech recommmends that you use twisted pair conductors with wire lengths as short as possible.
   - Wire Sizes:
     - AC POWER: 1.3 mm² [16 AWG]
     - MOTOR POWER: 0.5 mm² [20 AWG]
     - CONTROL POWER: 0.34 mm² [22 AWG]

3. System Wiring: SPECIFICATIONS (continued)
   - Wire Conformity:
     - North America: UL AWM
     - EU: <HAR>/CE
4. System Control and Motor VDC Power Supplies
   - Minimum Requirements:
     - Pollution Degree 2
     - Double insulated
     - Short-circuit and over-voltage protection
     - UL and CE approvals
   - Recommended Power Supplies *:
     - 24 VDC Control Supply
       Mean Well P/N: NDR-75-24 (DIN Rail power supply, 75W 24V 3.2A)
     - 48 VDC Motor Supply
       Mean Well P/N: NDR-480-48 (DIN Rail power suppy, 480W 48V 10A)
     - 24 VDC Motor Supply
       Mean Well P/N: NDR-240-24 (DIN Rail power suppy, 240W 24V 10A)

   * Refer to the Mean Well "NDR Series Installation Manual"
5. System Protective Earth (PE) grounds
   - Keep PE wires as short as possible
   - Each PE wire must have a dedicated attach/termination point
   - Terminate each PE directly to the grounded component panel (and that the component panel conform to NOTE 1).
6. XC2/XC2e Controllers
   - Refer to assemblies **(A1)**, **(A2)**, and **(A3)**
   - If the controllers were purchased as an integrated system, refer to the System Interconnections drawing included with the system documentation.
7. Axis Feedback Cable Ferrite EMC Filters
   - Use Aerotech P/N: ECZ02348 (Fair-Rite P/N: 0446167281) Clamp-On filters
   - Attach the filter near to the feedback connector back-shell as illustrated
8. Axis Motor Cable Ferrite EMC Filters
   - Use Aerotech P/N: ECZ02367 (Fair-Rite P/N: 2631626402) ferrite cores on motor-phase leads A, B, and C
   - Attach the filter near to the controller's motor output terminals
9. AC Power Source EMC Filter (RECOMMENDED)
   - Not required for EMC compliance
   - Use Aerotech P/N: ECZ02398 (Laird P/N: #LFB360230-300)
     - Toroid-ring construction
     - Loop system AC1 and AC2 conductor pair two times tightly through the toroid
10. System AC Power EMC Filter (RECOMMENDED)
    - A filter is NOT required for EMC "Conducted Emissions" compliance
    - A filter IS required for EMC "Surge Immunity" compliance
    - Use Aerotech P/N: ECZ00284 (Schaffner P/N: FN2070-10-06) or equivalent
11. Metal Oxide Varistor (MOV) (RECOMMENDED)
    - Required for EMC "Surge Immunity" compliance
    - Install (1) MOV to each AC1 and AC2 line as shown
    - Use Aerotech P/N: EID00197 (Littelfuse P/N: V20E385P) or equivalent
12. System AC Power
    - The system AC power must have a fuse or circuit breaker protection
    - Voltages and currents are dependent on the selected power supplies and system axis requirements (refer to NOTE 4).
13. DIN-Rail Mounted Components
    - Use DIN Rail from Phoenix P/N: NS 35/ 7,5 PERF 2000MM - 0801733 or equivalent

The information on this page is for reference only and represents best practice applications.

Figure 2-28: System Interconnection Drawing (Best Practice)

2.7. PC Configuration and Operation Information

For more information about hardware requirements, PC configuration, programming, system operation, and utilities, refer to the Help file.

Chapter 3: -EB1 I/O Option Board

The -EB1 I/O option board has 8 digital inputs, 8 digital outputs, 1 analog input, 1 analog output, and PSO outputs.

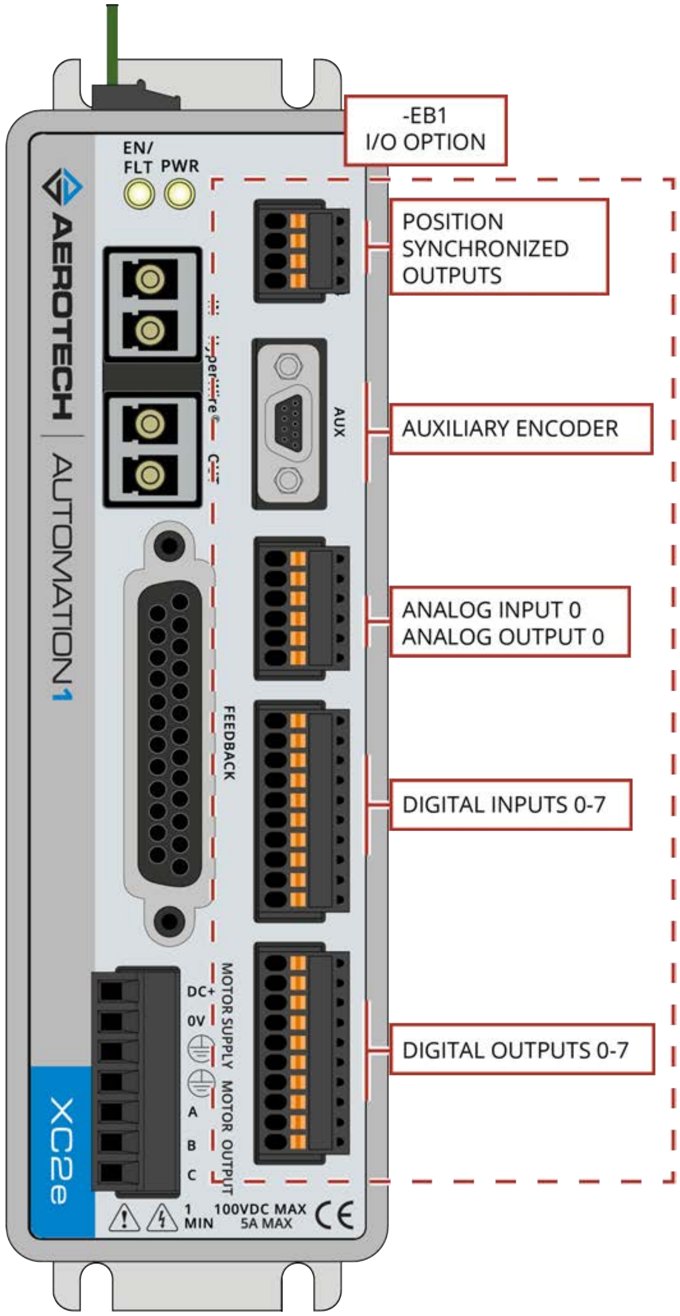


Figure 3-1: XC2e with -EB1 I/O Option Board Connectors

3.1. Position Synchronized Output Interface [-EB1]

The PSO output signal is available on the -EB1 option board in two signal formats: TTL and Isolated.

Table 3-1: PSO Specifications [-EB1]

Specification		Value
Output	TTL	5 V, 50 mA (max)
	Isolated	5-24 V, 250 mA
Maximum PSO Output (Fire) Frequency	TTL	12.5 MHz
	Isolated	5 MHz
Output Latency [Fire event to output change]	TTL	5 ns
	Isolated	150 ns

Table 3-2: PSO Interface Connector Pinout [-EB1]

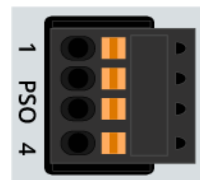
Pin #	Description	In/Out/Bi	Connector
1	PSO Output+	Output	
2	PSO Output-	Output	
3	PSO Output (TTL)	Output	
4	Ground	N/A	

Table 3-3: Mating Connector Part Numbers for the PSO Interface Connector [-EB1]

Type	Aerotech P/N	Third Party P/N	Wire Size: mm² [AWG]
4-Pin Terminal Block	ECK02399	Phoenix 1768004	0.5- 0.14 [20-26]

Isolated Signals

This output signal is a fully-isolated 5-24V compatible output capable of sourcing or sinking current. This output is normally open and only conducts current when a PSO fire event occurs.

The PSO Isolated Outputs are overload protected and will turn off if the maximum output current is exceeded.

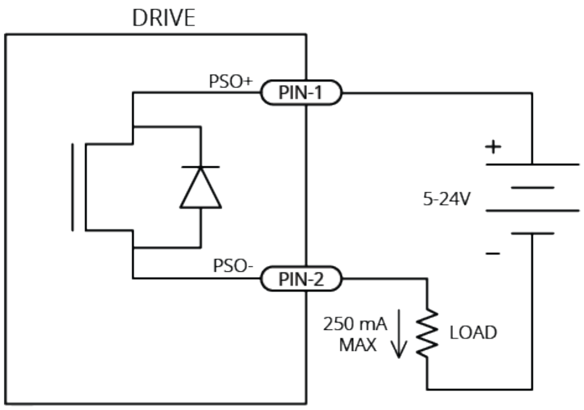


Figure 3-2: PSO Output Sources Current

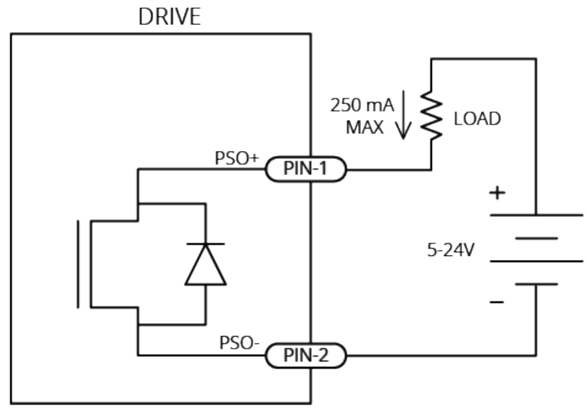


Figure 3-3: PSO Output Sinks Current

TTL Signals

This output signal is a 5V TTL signal which is used to drive an opto coupler or general purpose TTL input. This signal is active high and is driven to 5V when a PSO fire event occurs.

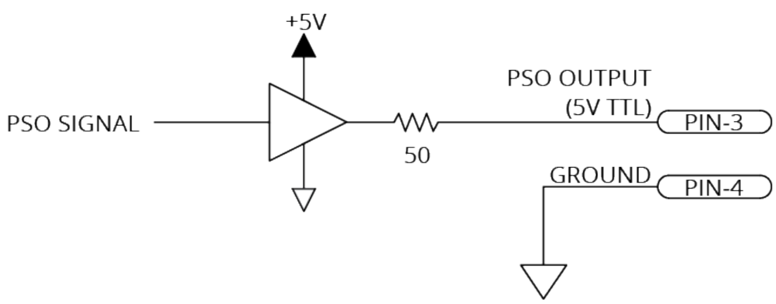


Figure 3-4: PSO TTL Outputs Schematic

3.2. Auxiliary Encoder Input [-EB1]

The Auxiliary Encoder connector gives you a second encoder input channel. This channel is typically used for dual loop applications.

Use the AuxiliaryFeedbackType parameter to configure the XC2e to accept an encoder signal type.

Square Wave encoder signals: Section 3.2.1.

Sine Wave encoder signals (with the -MX3 option): Section 3.2.2.

You can configure the Auxiliary Encoder interface as an output that will transmit encoder signals for external use. Use the DriveEncoderOutputConfigureInput() function to configure the Sine ± and Cosine ± connector pins as RS-422 outputs. You can only echo incremental square wave primary encoder inputs or, with the with the -MX2 or -MX3 option, incremental sine wave primary encoder inputs.

Table 3-4: Auxiliary Encoder Connector Pinout

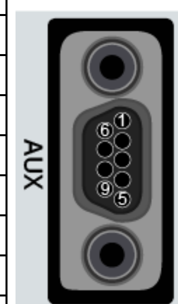
Pin#	Description	In/Out/Bi	Connector
1	Auxiliary Marker -	Input	
2	Auxiliary Cosine+	Bidirectional	
3	Auxiliary Cosine-	Bidirectional	
4	Auxiliary Sine+	Bidirectional	
5	Encoder Cable Shield	N/A	
6	Auxiliary Marker +	Input	
7	+5 Volt (500 mA max)	N/A	
8	Signal Common	N/A	
9	Auxiliary Sine-	Bidirectional	

Table 3-5: Mating Connector Part Numbers for the AUX Connector

Adapter Cable	Aerotech P/N	Third Party P/N
9-Pin Standard D-style	C20931	N/A
25-Pin Standard D-style	C20932	N/A
Flying Leads	ECZ01343	Molex 83421-9042

3.2.1. Square Wave Encoder

The XC2e accepts RS-422 square wave encoder signals. The XC2e will generate a feedback fault if it detects an invalid signal state caused by an open or shorted signal connection. Use twisted-pair wiring for the highest performance and noise immunity.

Table 3-6: Square Wave Encoder Specifications

Specification	Value
Encoder Frequency	10 MHz maximum (25 ns minimum edge separation)
x4 Quadrature Decoding	40 million counts/sec

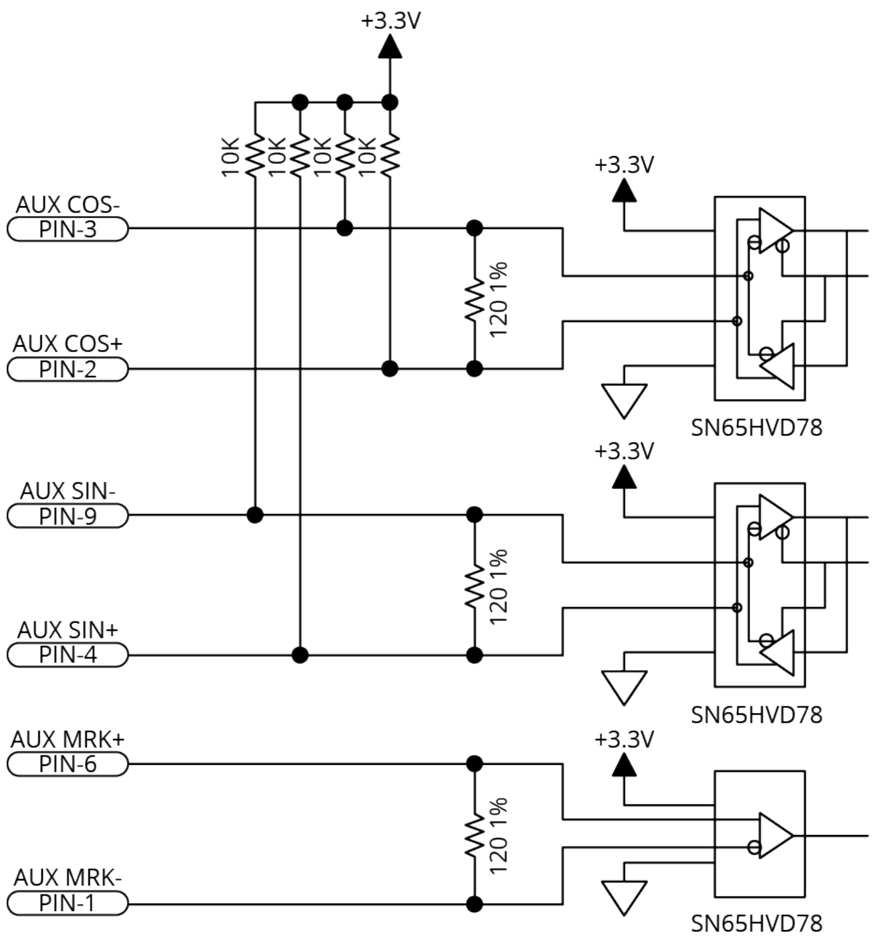


Figure 3-5: Square Wave Encoder Interface (Aux Connector)

3.2.2. Sine Wave Encoder [-MX3 Option]

The Sine Wave Encoder option provides higher positioning resolution by subdividing the fundamental output period of the encoder into smaller increments. The amount of subdivision is specified by the AuxiliaryEncoderMultiplicationFactor parameter. Use Encoder Tuning to adjust the value of the gain, offset, and phase balance controller parameters to get the best performance. For more information, refer to the Help file.

You cannot use the sine wave encoder on the auxiliary connector with the -MX3 multiplier option as an input to the PSO. The -MX3 option does not generate emulated quadrature signals from the auxiliary connector.

For the highest performance, use twisted pair double-shielded cable with the inner shield connected to signal common and the outer shield connected to frame ground. Do not join the inner and outer shields in the cable.

Table 3-7: Sine Wave Encoder Specifications

Specification		Value	
		Primary	Auxiliary
Input Frequency (max)		200 kHz, 2 MHz	200 kHz
Input Amplitude (1)		0.6 to 1.75 Vpk-pk	
Interpolation Factor (max)	-MX2	65,536	N/A
	-MX3	65,536	16,384
-MX2/-MX3 Primary Encoder Channel Interpolation Latency		800 nsec (analog input to quadrature output)	
Input Common Mode		1.5 to 3.5 VDC	
(1) Measured as SIN(+) - SIN(-) or COS(+) - COS(-)			

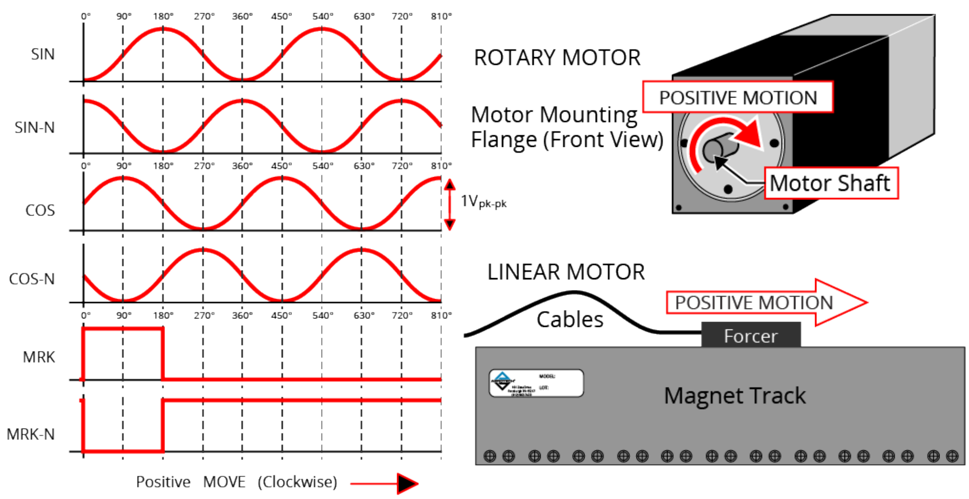


Figure 3-6: Sine Wave Encoder Phasing Reference Diagram

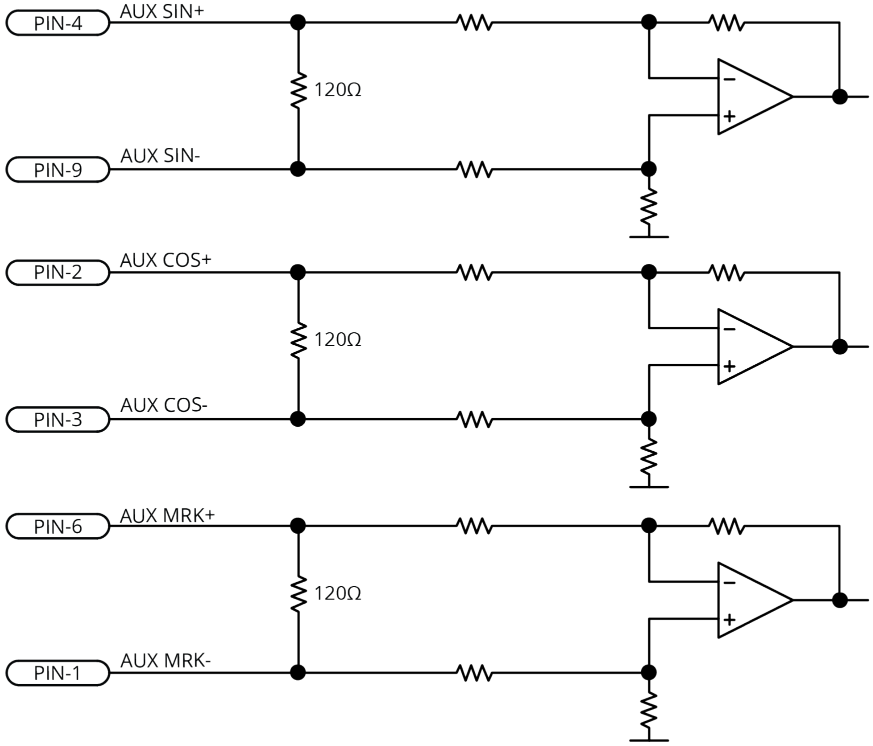


Figure 3-7: Sine Wave Encoder Schematic (Aux Connector)

3.3. Analog I/O [-EB1]

The Analog I/O connector has one differential analog input and one analog output.

Table 3-8: Analog I/O Connector Pinout [-EB1]

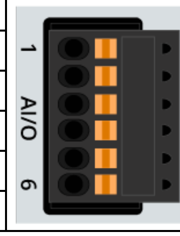
Pin#	Description	In/Out/Bi	Connector
1	+5 V (250 mA max)	N/A	
2	Analog Input 0+	Input	
3	Analog Input 0-	Input	
4	Ground	N/A	
5	Ground	N/A	
6	Analog Output 0	Output	

Table 3-9: Mating Connector Part Numbers for the Analog I/O Connector [-EB1]

Type	Aerotech P/N	Third Party P/N	Wire Size: mm^2 [AWG]
6-Pin Terminal Block	ECK02405	Phoenix 1704755	0.5 - 0.14 [20-26]

3.3.1. Analog Input (Differential) [-EB1]

To interface to a single-ended, non-differential voltage source, connect the signal common of the source to the negative input and connect the analog source signal to the positive input. A floating signal source must be referenced to the analog common. Refer to Figure 3-8.

Table 3-10: Differential Analog Input Specifications [-EB1]

Specification	Value
(AI+) - (AI-)	+10 V to -10 V (1)
Resolution (bits)	16 bits
Input Impedance	1 MΩ
1. Signals outside of this range may damage the input	

Table 3-11: Analog Input Pins on the Analog I/O Connector [-EB1]

Pin#	Description	In/Out/Bi
1	+5 V (250 mA max)	N/A
2	Analog Input 0+	Input
3	Analog Input 0-	Input
4	Ground	N/A

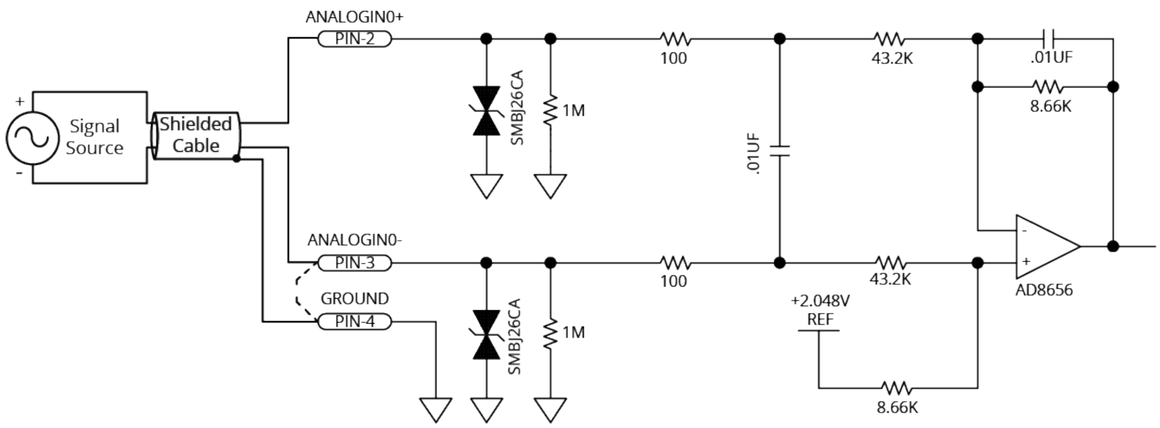


Figure 3-8: Analog Input Schematic [-EB1]

3.3.2. Analog Output 0 [-EB1]

The analog output can be set from within a program or it can be configured to echo the state of select servo loop nodes.

The analog output is set to zero when you power on the system or reset the drive.

Table 3-12: Analog Output Specifications [-EB1]

Specification	Value
Output Voltage	-10 V to +10 V
Output Current	5 mA
Resolution (bits)	16 bits

Table 3-13: Analog Output Pins on the Analog I/O Connector [-EB1]

Pin#	Description	In/Out/Bi
5	Ground	N/A
6	Analog Output 0	Output

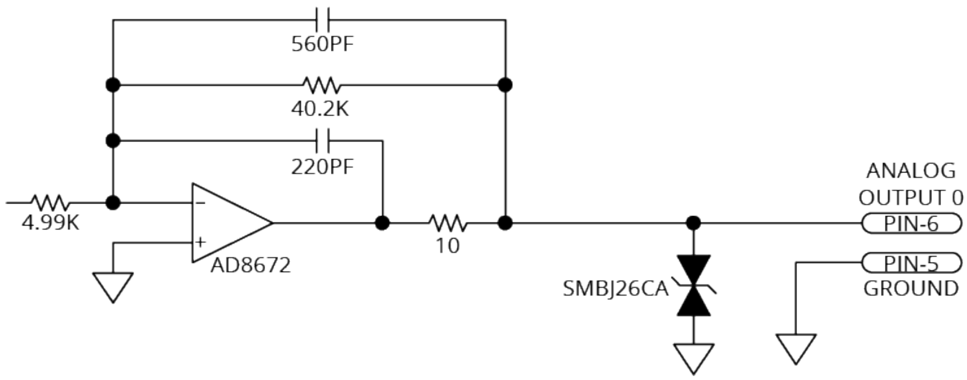


Figure 3-9: Analog Output Schematic [-EB1]

3.4. Digital Inputs [-EB1]

Input bits are arranged in groups of 4 and each group shares a common pin. This lets a group be connected to current sourcing or current sinking devices, based on the connection of the common pin in that group.

To be able to connect an input group to current sourcing devices, connect the input group's common pin to the power supply return (-). Refer to Figure 3-11.

To be able to connect an input group to current sinking devices, connect the input group's common pin to the power supply source (+). Refer to Figure 3-12.

The digital inputs are not designed for high-voltage isolation applications. They should only be used with ground-referenced circuits.

Table 3-14: Digital Input Specifications [-EB1]

Input Voltage	Approximate Input Current	Turn On Time	Turn Off Time
+5 V to +24 V	6 mA	10 μs	43 μs

Table 3-15: Digital Input Connector Pinout [-EB1]

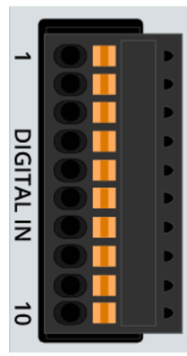
Pin#	Description	In/Out/Bi	Connector
1	Input Common for Inputs 0-4	N/A	
2	Input 0 (Optically-Isolated)	Input	
3	Input 1 (Optically-Isolated)	Input	
4	Input 2 (Optically-Isolated)	Input	
5	Input 3 (Optically-Isolated)	Input	
6	Input Common for Inputs 4-7	N/A	
7	Input 4 (Optically-Isolated)	Input	
8	Input 5 (Optically-Isolated)	Input	
9	Input 6 (Optically-Isolated)	Input	
10	Input 7 (Optically-Isolated)	Input	

Table 3-16: Mating Connector Part Numbers for the Digital Input Connector [-EB1]

Mating Connector	Aerotech P/N	Third Party P/N	Wire Size: mm² [AWG]
10-Pin Terminal Block	ECK02395	Phoenix 1700841	0.5 - 0.14 [20-26]

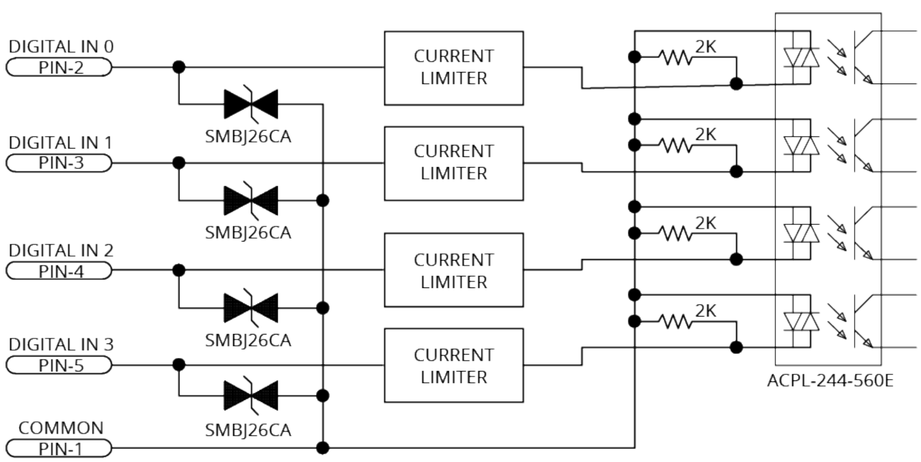


Figure 3-10: Digital Inputs Schematic [-EB1]

Each bank of four inputs must be connected in an all sourcing or all sinking configuration.

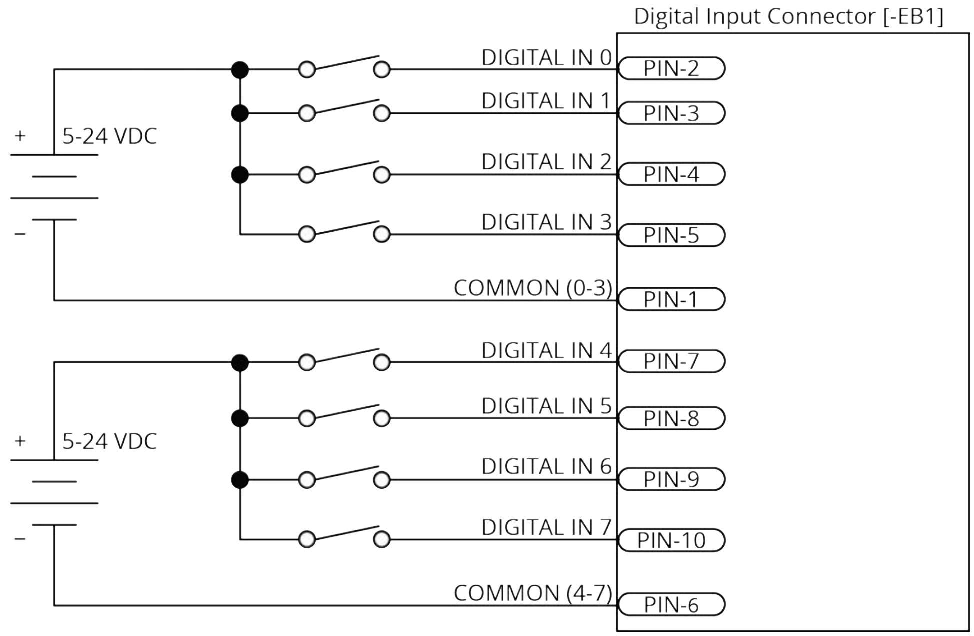


Figure 3-11: Digital Inputs Connected to Current Sourcing (PNP) Devices [-EB1]

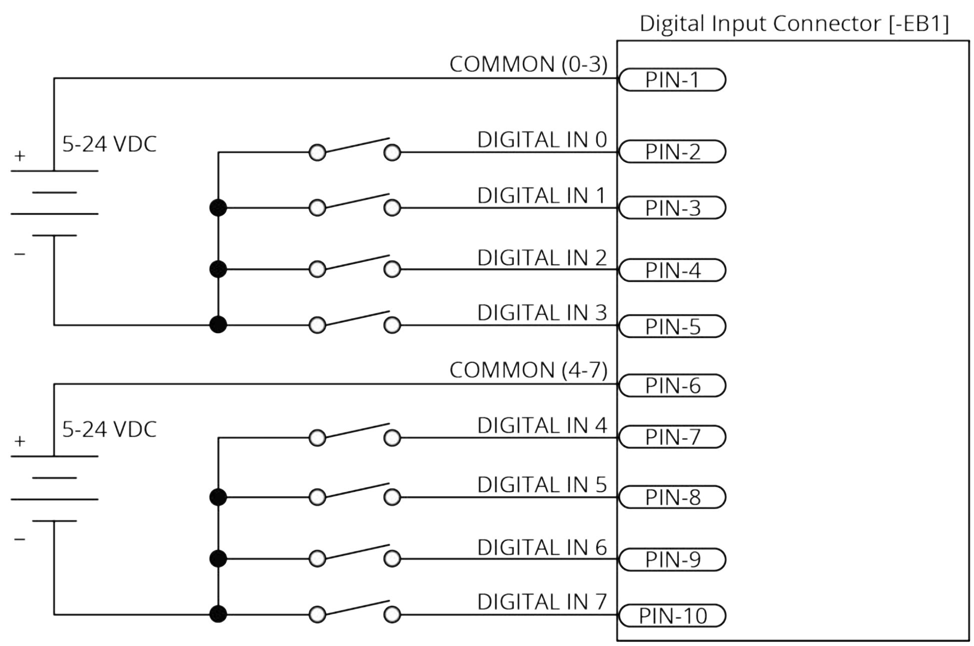


Figure 3-12: Digital Inputs Connected to Current Sinking (NPN) Devices [-EB1]

3.5. Digital Outputs [-EB1]

Optically-isolated solid-state relays drive the digital outputs. You can connect the digital outputs in current sourcing or current sinking mode but you must connect all four outputs in a port in the same configuration. Refer to Figure 3-14 and Figure 3-15.

The digital outputs are not designed for high-voltage isolation applications and they should only be used with ground-referenced circuits.

You must install suppression diodes on digital outputs that drive relays or other inductive devices. To see an example of a current sourcing output that has diode suppression, refer to Figure 3-14. To see an example of a current sinking output that has diode suppression, refer to Figure 3-15

The digital outputs have overload protection. They will resume normal operation when the overload is removed.

Table 3-17: Digital Output Specifications [-EB1]

Digital Output Specifications	Value
Maximum Voltage	24 V (26 V Maximum)
Maximum Sink/Source Current	250 mA/output
Output Saturation Voltage	0.9 V at maximum current
Output Resistance	3.7 Ω
Rise / Fall Time	250 µs (2K pull up to 24V)
Reset State	Output Off (High Impedance State)

Table 3-18: Digital Output Connector Pinout [-EB1]

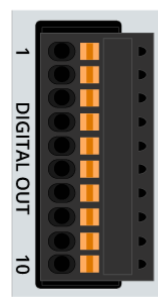
Pin#	Description	In/Out/Bi	Connector
1	Output Common for Outputs 0-3	N/A	
2	Output 0 (Optically-Isolated)	Output	
3	Output 1 (Optically-Isolated)	Output	
4	Output 2 (Optically-Isolated)	Output	
5	Output 3 (Optically-Isolated)	Output	
6	Output Common for Outputs 4-7	N/A	
7	Output 4 (Optically-Isolated)	Output	
8	Output 5 (Optically-Isolated)	Output	
9	Output 6 (Optically-Isolated)	Output	
10	Output 7 (Optically-Isolated)	Output	

Table 3-19: Mating Connector Part Numbers for the Digital Output Connector [-EB1]

Mating Connector	Aerotech P/N	Third Party P/N	Wire Size: mm^2 [AWG]
10-Pin Terminal Block	ECK02395	Phoenix 1700841	0.5 - 0.14 [20-26]

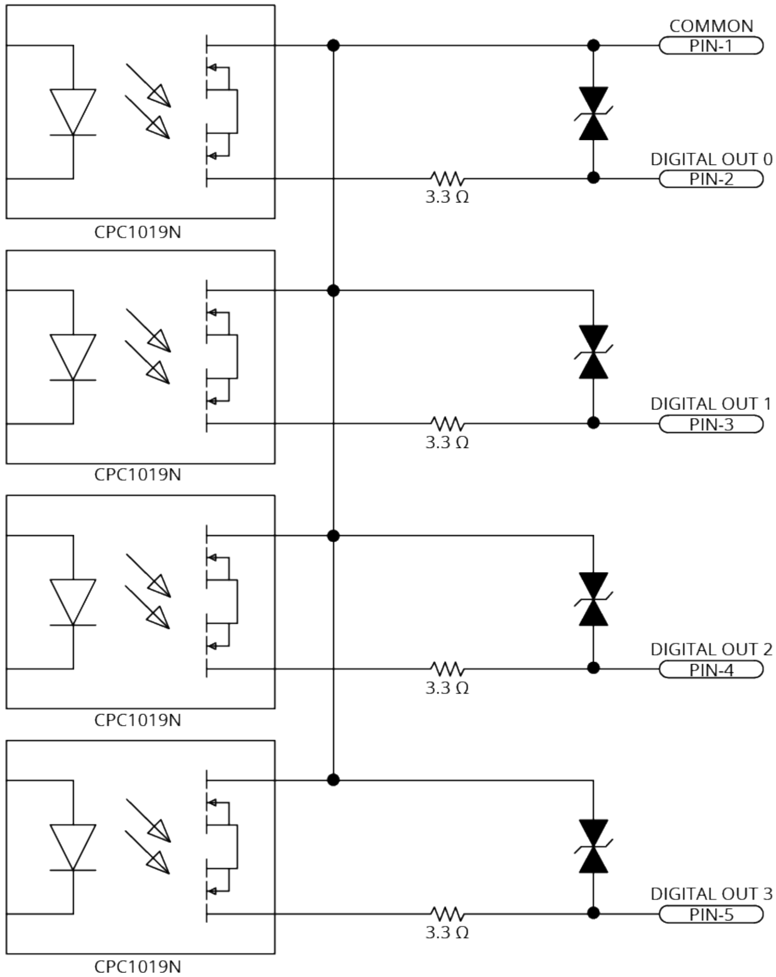


Figure 3-13: Digital Outputs Schematic [-EB1]

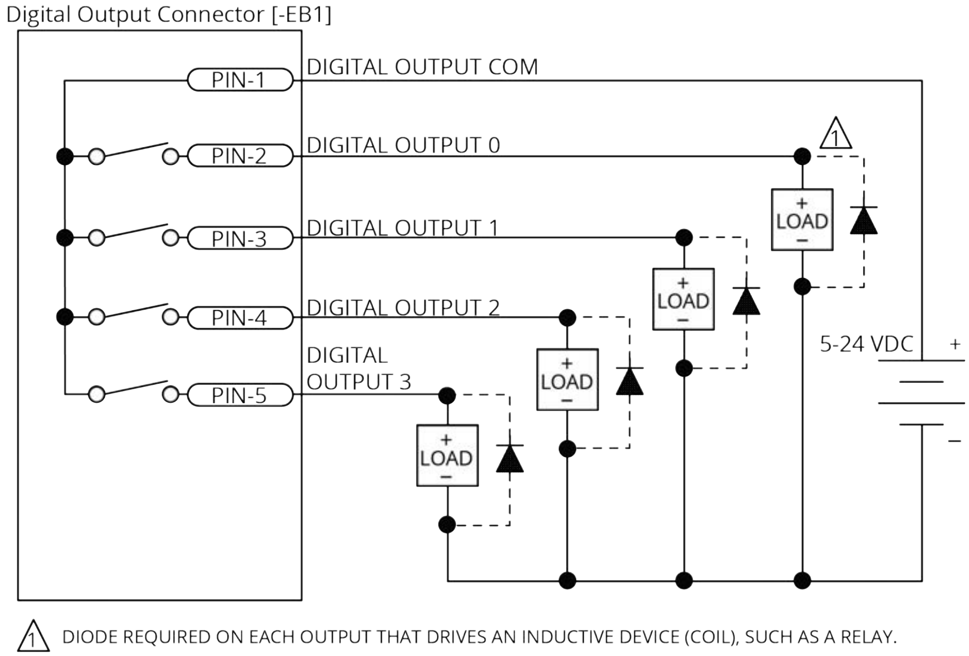


Figure 3-14: Digital Outputs Connected in Current Sourcing Mode [-EB1]

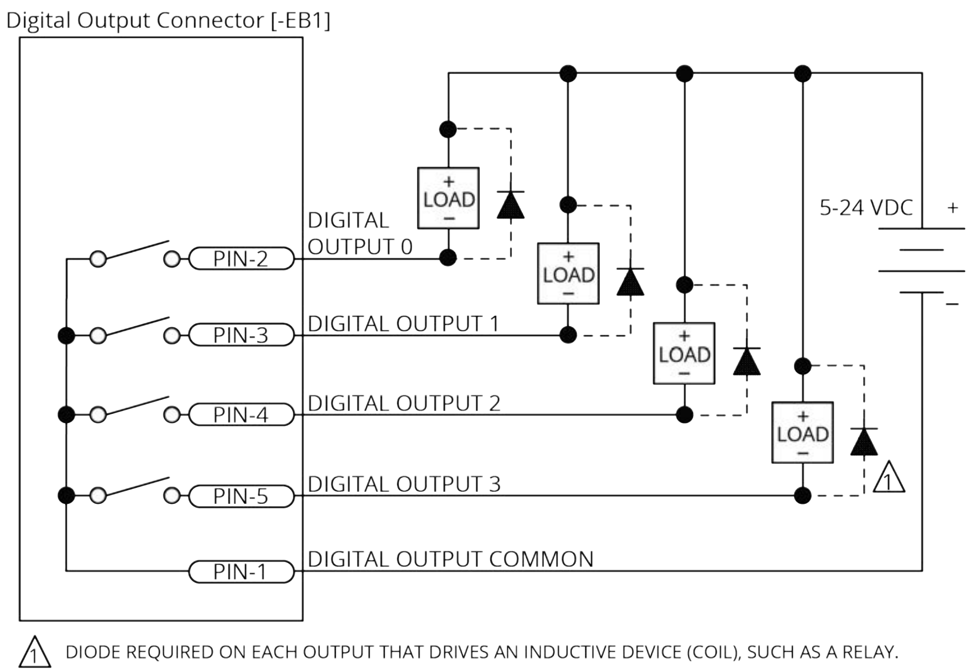


Figure 3-15: Digital Outputs Connected in Current Sinking Mode [-EB1]

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Chapter 4: Cables and Accessories

IMPORTANT: Find Aerotech cable drawings on the website at http://www.aerotechmotioncontrol.com/manuals/index.aspx.

Table 4-1: Standard Interconnection Cables

Cable Part #	Description
Joystick	Refer to Section 4.2. Joystick Interface
Handwheel	Refer to Section 4.3. Handwheel Interface
ECZ03125-3 and ECZ03125-9	Dual-PSO Adapter Cable (refer to Section 4.4. Dual-PSO Adapter Cable).
C20934-XX or C20935-XX	BB-MP Interconnect Cable (Refer to the BB-MP manual)

4.1. DIN Rail Mounting

DIN Rail Mounting Procedure:

1. Mount the DIN rail clip to the XC2e. The clip and #6-32 x 1/4 flat head screws are included in the XC2e-DIN clip kit.
2. Cut the DIN rail so that one complete mounting hole extends beyond the last component at each end.
3. Secure the DIN Rail to the mounting surface with #10-32 screws spaced every six inches.
NOTE: Do not install the DIN rail to the mounting surface with the components already attached.
4. Install all components on to the DIN rail.

IMPORTANT: Refer to the Automation1 PS2 DIN Rail Power Supply hardware manual for more information.

Table 4-2: Mounting Parts

	Aerotech P/N
DIN Rail	EAM00914
DIN Rail Clip Kit	XC2e-DIN

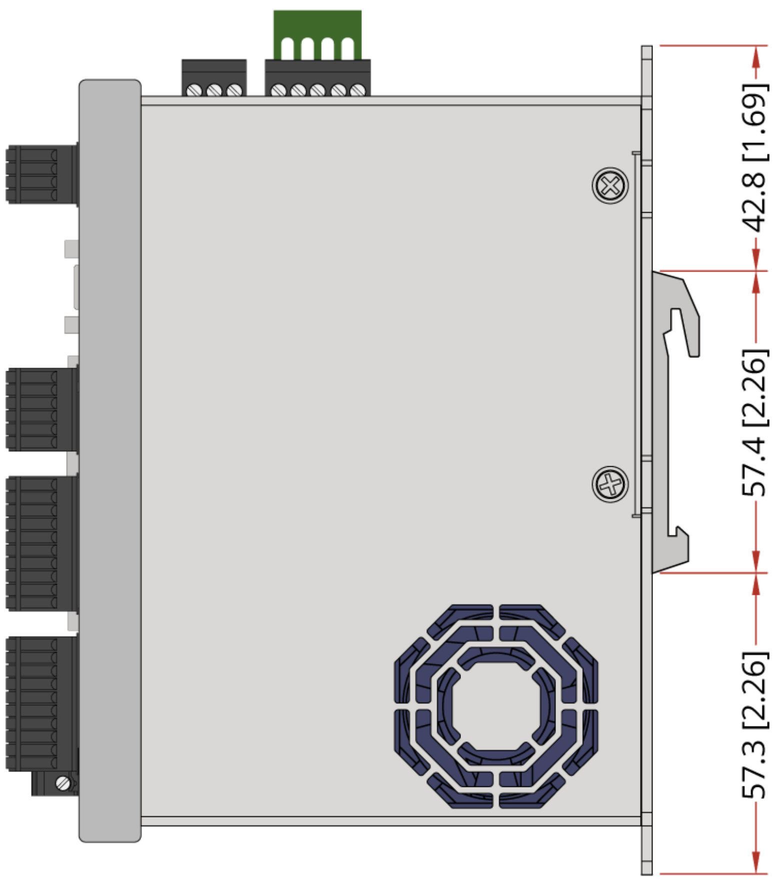

Figure 4-1: Din Rail Clip Dimensions

4.2. Joystick Interface

Aerotech Multi-Axis Joystick (NEMA12 (IP54) rated) is powered from 5 V and has a nominal 2.5 V output in the center detent position. Three buttons are used to select axis pairs and speed ranges. An optional interlock signal is used to indicate to the controller that the joystick is present. Joystick control will not activate unless the joystick is in the center location. Third party devices can be used provided they produce a symmetric output voltage within the range of -10 V to +10 V.

Connecting joystick with an Aerotech cable, all Aerotech cables are labeled to identify the connector and connections. The joystick parameters must be set to match the analog and digital I/O connections.

The following drawings illustrate how to connect a single- or two-axis joystick. Refer to the Help file for programming information about how to change joystick parameters.

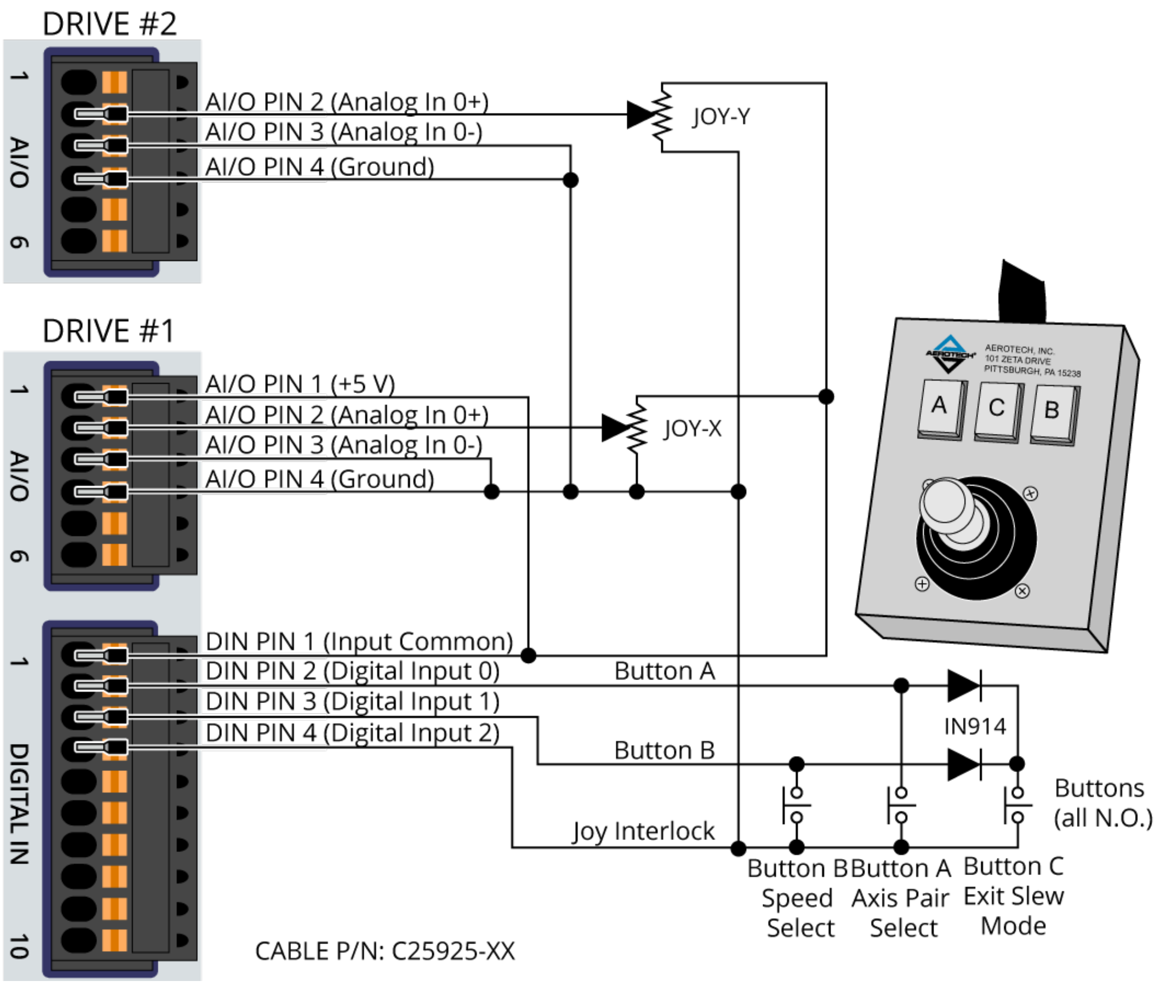

Figure 4-2: Two Axis Joystick Interface

4.3. Handwheel Interface

A handwheel can be used to manually control axis position. The handwheel must provide 5V differential quadrature signals to the XC2e.

IMPORTANT: You can find instructions on how to enable the handwheel in the Help file.

Connect a handwheel to the Aux connector as shown in Figure 4-3.

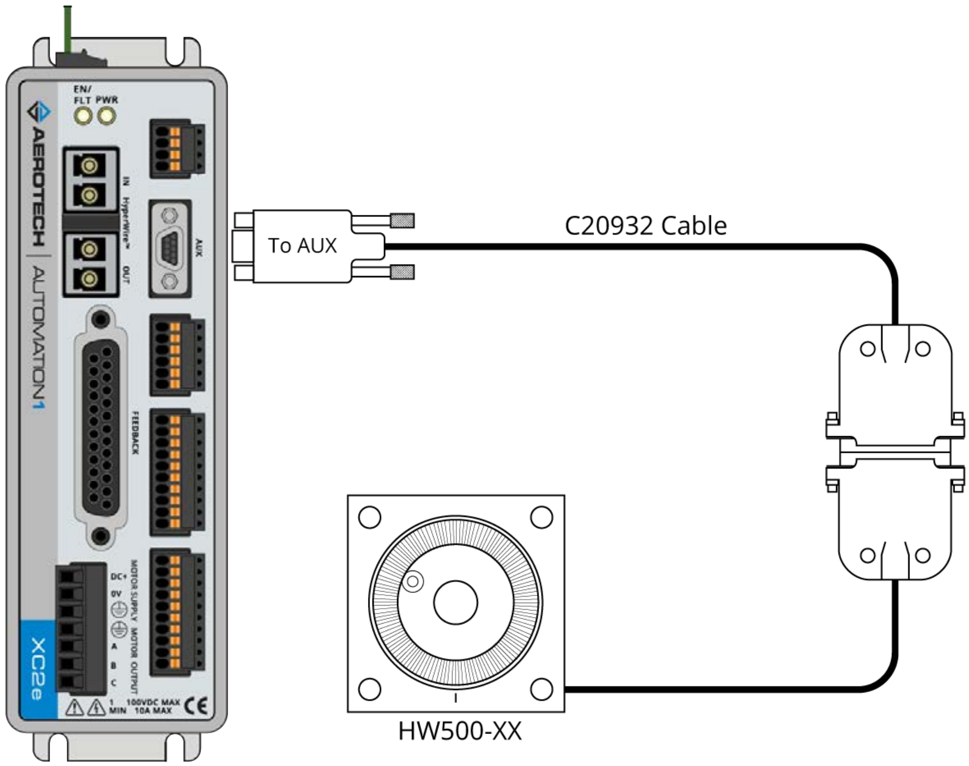

Figure 4-3: Handwheel Interconnection to the Aux Connector

4.4. Dual-PSO Adapter Cable

The dual-PSO adapter cable is available in two lengths:

3 dm (9.84 in)

9 dm (29.52 in)

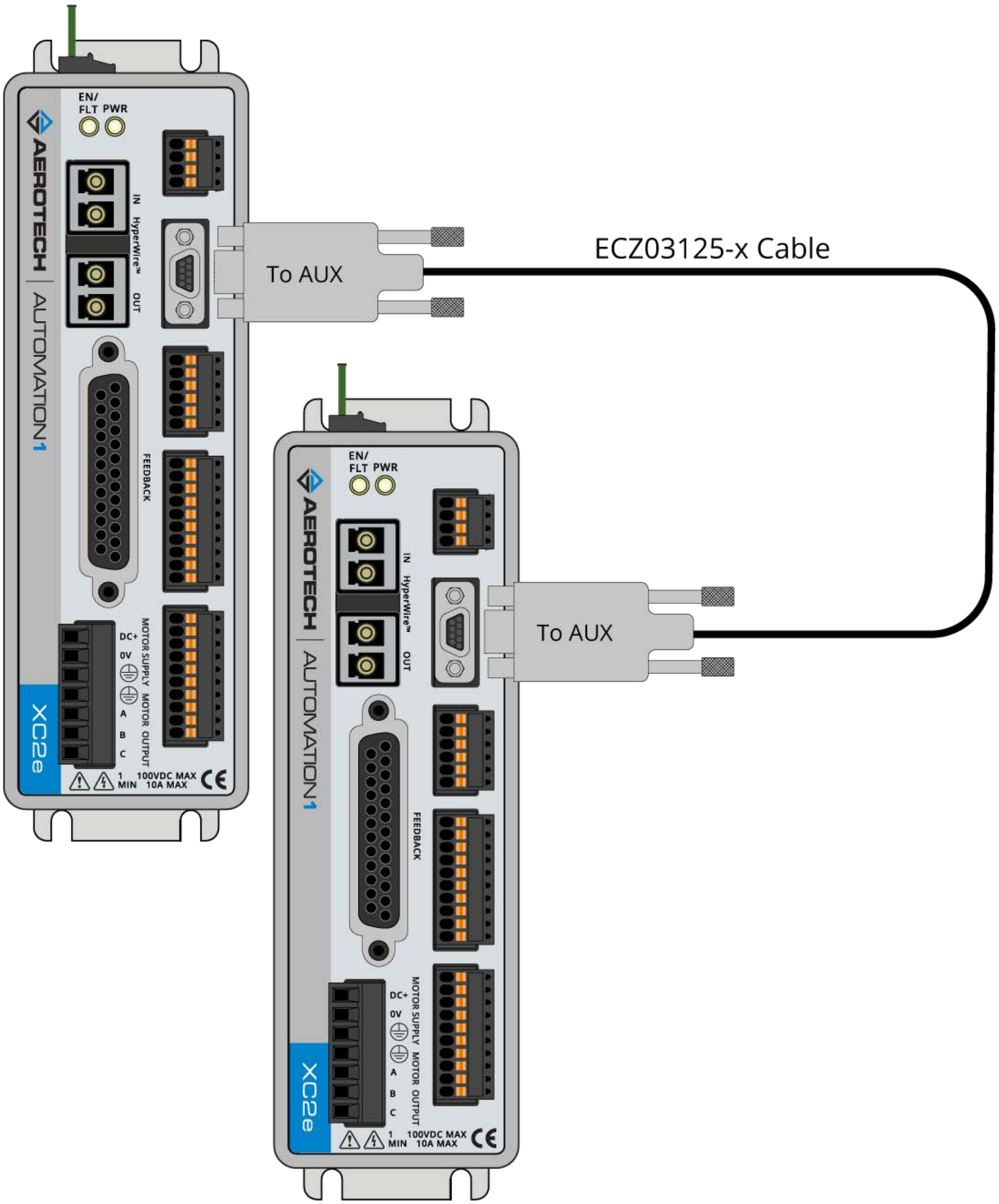

Figure 4-4: Dual-Axis PSO Cable Connection

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Chapter 5: Maintenance

IMPORTANT: For your own safety and for the safety of the equipment:

- Do not remove the cover of the XC2e.
- Do not attempt to access the internal components.

A fuse that needs to be replaced indicates that there is a more serious problem with the system or setup. Contact Global Technical Support for assistance.

DANGER: If you must remove the covers and access any internal components be aware of the risk of electric shock.

1. Disconnect the Mains power connection.
2. Wait at least one (1) minute after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.
3. All tests must be done by an approved service technician. Voltages inside the controller and at the input and output power connections can kill you.

Table 5-1: LED Description

LED	Color	Description
PWR	GREEN	The light will illuminate and remain illuminated while power is applied.
EN/FLT	GREEN	The axis is Enabled.
	RED	The axis is in a Fault Condition.
	GREEN/RED (alternates)	The axis is Enabled in a Fault Condition. or The light is configured to blink for setup.

Table 5-2: Troubleshooting

Symptom	Possible Cause and Solution
No Communication	Make sure the power LED is illuminated (this indicates that power is present).
	Make sure that all communication cables (HyperWire, for example) are fully inserted in their ports.

5.1. Preventative Maintenance

Do an inspection of the XC2e and the external wiring one time each month. It might be necessary to do more frequent inspections based on:

- The operating conditions of the system.
- How you use the system.

Table 5-3: Preventative Maintenance

Check	Action to be Taken
Examine the chassis for hardware and parts that are damaged or loose. It is not necessary to do an internal inspection unless you think internal damage occurred.	Repair all damaged parts.
Do an inspection of the cooling vents.	Remove all material that collected in the vents.
Examine the work area to make sure there are no fluids and no electrically conductive materials.	Do not let fluids and electrically conductive material go into the XC2e.
Examine all cables and connections to make sure they are correct.	Make sure that all connections are correctly attached and not loose. Replace cables that are worn. Replace all broken connectors.

Cleaning

DANGER: Before you clean the XC2e, disconnect the electrical power from the drive.

Use a clean, dry, soft cloth to clean the chassis of the XC2e. If necessary, you can use a cloth that is moist with water or isopropyl alcohol. If you use a moist cloth, make sure that moisture does not go into the XC2e. Also make sure that it does not go onto the outer connectors and components.

Do not use fluids and sprays to clean the XC2e because they can easily go into the chassis or onto the outer connectors and components. If a cleaning solution goes into the XC2e, internal contamination can cause corrosion and electrical short circuits.

Do not clean the labels with a cleaning solution because it might remove the label information.

5.2. Fuse Specifications

WARNING: Replace fuses only with the same type and value.

Table 5-4: Control Board Fuse Specifications

Fuse	Description	Size	Aerotech P/N	Third Party P/N
F1	Control Power at +24V Input	2 A S.B.	EIF01066	Littelfuse 0473002.MRT1L
F2	Motor Power at DC+ Input	5 A S.B.	EIF01061	Littelfuse 39215000440

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Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from harmful defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech’s liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech’s products are specifically designed and/or manufactured for buyer’s use or purpose. Aerotech’s liability on any claim for loss or damage arising out of the sale, resale, or use of any of its products shall in no event exceed the selling price of the unit.

THE EXPRESS WARRANTY SET FORTH HEREIN IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL AEROTECH BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES.

Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within thirty (30) days of shipment of incorrect material. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. A "Return Materials Authorization (RMA)" number must accompany any returned product(s). The RMA number may be obtained by calling an Aerotech service center or by submitting the appropriate request available on our website (www.aerotech.com). Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than thirty (30) days after the issuance of a return authorization number will be subject to review.

Visit Global Technical Support Portal for the location of your nearest Aerotech Service center.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an expedited method of return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Fixed Fee Repairs - Products having fixed-fee pricing will require a valid purchase order or credit card particulars before any service work can begin.

All Other Repairs - After Aerotech's evaluation, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within thirty (30) days of notification will result in the product(s) being returned as is, at the buyer's expense.

Repair work is warranted for ninety (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

> Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special rates apply.
>
> If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following “On-Site Non-Warranty Repair” section apply.

On-site Non-Warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

> Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Service Locations

http://www.aerotech.com/contact-sales.aspx?mapState=showMap

USA, CANADA, MEXICO	CHINA	GERMANY
Aerotech, Inc. Global Headquarters	Aerotech China Full-Service Subsidiary	Aerotech Germany Full-Service Subsidiary
TAIWAN	**UNITED KINGDOM**	
Aerotech Taiwan Full-Service Subsidiary	Aerotech United Kingdom Full-Service Subsidiary	

Appendix B: Revision History

Revision	Description
2.01	Updated: • Section 2.5. HyperWire Interface • Section 2.6. System Interconnection • Section 3.2. Auxiliary Encoder Input [-EB1] • Section 3.2.2. Sine Wave Encoder [-MX3 Option]
2.00	New Manual

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